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SELECTIVE FACTORS IN HUMAN SURVIVAL[1]

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In ancient times, when that other Athens was the center of the culture, the art and the glory of Greece, it was boldly presumptuous for a crude outsider from less enlightened areas to bring a message to the Athenians. To speak where Demosthenes had spoken, to teach where Plato had taught or to build where Pericles had builded, was an assignment to an evangelistic enterprise of gargantuan proportions. If mine is a similar assignment, you are assured that I have not recently experienced any great light of inspiration and have suffered no impairment of vision that was unresponsive to optometric adjustment of my bifocals. But Paul came to an Athens that was in decline under the weight of Roman domination and I come to a center of learning surging with a burst of vigor that has recently humbled our basketball and swimming teams, and even challenges our long term supremacy on the football field.

It is an established practice for the retiring president of our Academy to render a rhetorical swan-song on this occasion. It is also more or less traditional that this final, unmusical effort consist of a restatement of the policies and prejudices for which the speaker has long been noted among his colleagues. It satisfies the ego of the speaker and may even impress his auditors, if his offering can be presented in the guise of a research project. Now scientific research, or at least most biological research, is characterized by three well-defined stages. First, there is the *pedal* or footwork stage which consists in the collection of materials or data as the basis for the remainder of the project. Some enthusiastic field men perform prodigious feats of pedal research and amass great quantities of unorganized materials for others to classify. The second stage of research is the *manual* or handling operations for the materials concerned. This involves preparation, classification or calculation, depending upon the nature of the material involved. The third stage is the *cerebral* or analysis aspect which involves the interpretation and application of the materials of the first two stages. It is sometimes surprising to note how much cerebration can be done with a minimum of pedal and manual activity. Ponderous researches of this type are usually held in high respect, despite the lingering suspicion that some of these efforts are less cerebral and more gluteal in nature.

The pedal part of my investigations which shall serve as a basis for later discussion were collected by the distribution of a simple questionnaire to my students in a course dealing with Human Heredity and catalogued under the title *Eugenics*. This one semester, no prerequisite course, has been offered each semester of the college year for the past twenty years. The questionnaire has been submitted for seventeen years for the collection of this information:

[1]Presidential address delivered at the Annual Meeting of the Ohio Academy of Science at Ohio University, Athens, Ohio, April 16, 1954.

VITAL STATISTICS QUESTIONNAIRE

Name_____ Age_____

Number of your brothers Dead_____ Living_____ Number of your sisters Dead_____ Living_____

Number of your father's brothers reaching maturity (20 yrs.) _____

" " " " sisters " " " " _____

Number of your mother's brothers " " " " _____

" " " " sisters " " " " _____

Age of parents at marriage: Father_____ Mother_____

Education (*common school, high school, or college*) of parents:

Father_____ Mother_____

Occupation of Father_____

Remarks or explanations:_____

This blank has been filled by and collected from 1025 students. Seventeen years of counting and calculating can be summarized thus:

Students' families average.....2.61
Parents' families average.....4.41

Decline in one generation..... 1.8 children.

Older parents (especially older mothers) have fewer children than younger parents.

Size of the family varies inversely with the education of the mother.

W. S. Thompson of the Scripps Foundation for Population Studies obtained similar information from 931 Miami students thirty years ago and found:

Students' families averaged.....3.5
Parents' families averaged.....5.81

Decline in one generation.....2.31 children.

The fact that our average student family size over seventeen years was much smaller than that recorded by Thompson from a single sampling in 1924 might suggest a progressive decline in size of students' families over our period of study. Such was not the case since our smallest student family average (2.2) was in 1947 and our largest (3.57) was in 1948. Our great drop in the size of parents' families (5.81 to 4.41) is to be correlated with the fact that many of the students of Thompson's study are the parents of our recent respondents.

I now follow the standard lecture procedure of digressing from my introductory theme to present a general picture of the basic facts of selection in nature.

Every modern species of plant or animal, in fact every variety and every individual now in existence, represents the present expression of a line of living organisms extending back in unbroken succession to that mysterious and undefined period which marks the beginning of life on our planet. I realize that present investigations, relative to the possible synthesis of living particles through the action of desoxyribose nucleic acid molecules, offer an intriguing speculation as to the continuing origin of organisms at the lowest order of the life scale, but currently we shall subscribe to time-honored cliché which states that "All life comes from life." Any organism alive today stands at the apex of a line of life that has, thus far, solved the problems of survival. That engineering marvel which is your modern automobile is the result of thousands of changes and modifications but all *living* things have been tried and selected from countless millions through untold ages.

We marvel at the prolificacy of nature when we give consideration to the nine million eggs of a single codfish, the burden of winged seeds born by a single maple tree, the dance of mating mayflies over miles of lake and shore, or a migration of grasshopper hordes which darken the sun. Yet in spite of these prolific

reproductive potentials, the cod scarcely hold its numbers, the seeds of the maple reach sterile ground, the usual destination of a mayfly is the maw of a fish and the grasshopper hosts perish by the ton on unfriendly plains. This story can be repeated with slight variations for most species of the plant or animal kingdoms where the constant formula *is* overproduction, natural selection and survival of those few individuals which escape the hazards of existence.

As a representative animal in the living world, *man* has never been free from these laws of natural selection. In his primitive state he certainly passed through cycles where a strong arm and a thick skull were decisive selective factors. If we can picture ancient man as dwelling in cold, damp caves or under overhanging cliffs, having a minimum of sanitation and surrounded by a depreciating food supply, he was certainly attended by every type of vermin and parasite which modern medicine recognizes and subject to all the ailments now associated with these loathsome vectors. The selective factors of this period of human evolution would also be concerned with the ravages of hunger and disease, the fierce brawls attending mate selection and the frequent contests with cave-dwelling bears or wolves where crude weapons made an equal chance for the status of victor or vanquished. In ancient historical times, disease was a more powerful weapon than the sword, but we can only conjecture on the nature of many of the ancient plagues and pestilences. The "glance of the Lord" that melted the Assyrian hosts of Sennacherib before Jerusalem may have been dysentery, cholera or bubonic plague, and the Carthaginian armies of Hannibal most certainly found the malarial mosquitoes from the Pontine marshes more formidable enemies than the disordered legions of Rome. The selective agents of ancient historical times spanned the Dark Ages and reached the modern period with little diminution of their potency. One-fourth of the population of London perished from a single epidemic of plague in the 17th Century and pioneers of our area knew epidemics of smallpox and diphtheria of destructive proportions. Near the end of World War I the fearful sweep of influenza claimed more lives from the civilian populations of the contending nations than were lost by the military forces of all combatants. Medical men were helpless before the older plagues but the work of Jenner, Pasteur and Koch gave powerful weapons of defense to the nineteenth century and the recent discoveries in the field of antibiotics makes modern medicine an efficient selective factor in human survival. Given another century of comparable progress and the contagious diseases of childhood will become as infrequent and as disreputable as are body lice today. Contests for mates we still have but such are usually peaceful, or if otherwise, juries are lenient. No longer does man fear the invasion of wild beasts into his domain. He puts his trust in a high-powered rifle or sets a mouse trap.

We note the conquest of the selective factors that plagued our ancestors and hail a new system of medicine which seeks to preserve every human being from the moment of conception to the last feeble squeak of the age-worn mechanism. But before we become too enthusiastic over our new-found freedom from the bonds of natural selection, let us remember that not selection but *survival* is the key word in the perpetuation of a species or lesser group in a population. It should be noted that all selection which results in survival is *natural* selection. Man may change the character of his herds or his crop plants and he may devise medical agents to check or even prevent the operation of disease-causing agencies in human population, but these efforts are without value if the populations so benefited are not continued through reproduction. The pioneer grandmother who lost five children to diphtheria but raised seven to maturity now has a modern descendant whose *one* child has been vaccinated, innoculated, X-rayed, tuberculin tested and blood grouped before he enters college. If he survives traffic hazards and fraternity hazing, he is still the representative of a declining group in our population, a class that presents the most effective selection of all times,

the failure to reproduce at a survival level. No other selective factor can possibly be so fatal as *not being born.*

It has previously been indicated that any individual alive today is the present representative of an unbroken line of evolution. It should be further noted that the continuity of this line depends upon continued reproduction of the species, class or individual concerned. Any individual that dies without issue is just as extinct as a dinosaur, a mastodon or a passenger pigeon but the saving factor in individual extinction is the fact that the component units of any particular individual's hereditary makeup (the *genes* of the students of Biology) are still present in corollary lines of reproductive individuals. Our concern is therefore not centered so much in individuals (they are expendable) as in that *group* of our population wherein we find collections of the best human traits. The inheritance of superior traits has been amply demonstrated by a series of investigators from Galton in the 1870's, through the findings of Terman in the 1920's, to more recent studies of parent-child I.Q. correlations. Since general intelligence is a multiple factor inheritance, a statistical analysis of parent-child relationship in mental ability show typical regression toward average norms but the general verdict finds that "like begets like" in *mental*, as well as physical traits. It is the common experience of teachers to find recurring examples of superior ability in the same family, and the observation of multiple abilities in the same individual sometimes make it difficult to decide *where* a generally superior pupil should enter contests for scholastic honors. Our present search for superior ability in science is matched by the efforts of others who seek superior abilities in athletics, music, and general scholarship. Never before in all the history of Ohio have the traits of her junior citizens been so efficiently recognized and classified. If these "gems of purest ray serene" are not brought from the unfathomed depths of obscurity to be polished by the abrasive action of public acclaim, it is not the fault of those who labor to organize basketball and baseball tournaments, track meets, music festivals, science days and scholarship tests. It is no accident that many of our Junior Academy contestants who are here today will also be representing their respective schools in other fields of competitive endeavor. That the winners in these contests will receive offers of scholarships or other inducements to enter our colleges is a foregone conclusion. We commend our colleges for presenting these inducements and express a regret that more and better offerings are not available.

Since the rewards offered do not approach the cost of a college career, there will be a selection in the acceptance of these scholarships. Parental aid may enable a student to go to college where the family finances will permit such aid, but the determination of the student may be firm enough to spur him to find the means of financing at least the beginning of a college career. If the family finances will be strained by the expense of a four-year college course, it is obvious that this expense will not stand frequent repetition; therefore, if the student comes from a family where the parents have planned a college career for their children, the family will be small. This observation corresponds with our findings of 2.61 children per family for the parents who had *one* child in our group. The decline of 1.8 children in one generation is the selective price of college for this group.

You may ask why we should be concerned over this declining rate of reproduction in the parents of our group or the failure of these graduates to replace themselves. College students have always been drawn from non-college parents more frequently than they have been produced by college graduates. These wells of supply for the desirable traits which we seek should produce in the future as they have in the past, the leaders which our complex civilization demands. This attitude was justified when selective pressures were inoperative and students came to us on their own initiative. Our present system of locating the best in every field of physical performance, artistic ability and scholastic endeavor com-

pares to putting a high speed irrigation pump on a well that formerly gave forth its yield by the bucketful. Before we "miss the water", we must learn to conserve. There is no more logical system of conservation of our genetic heritage than that of putting it back into circulation through the continued reproduction of those who have demonstrated their possession of that superior heritage.

Most of the students who are chosen by our several agencies will complete a college course, many of them with a distinctive record. The sifting selection of a college career offers few difficulties but they will be harrassed by a more rigid selection beyond their graduation. We shall examine the results of these selective factors and attempt an analysis of their operation. In 1947 Gamble made a survey of the 1921 and 1922 graduates of 76 colleges in the United States. These graduates showed an average of 1.75 children per male graduate and 1.39 children per female graduate, 25 or 26 years after college. If we average the figures (apologies to our statisticians) we get 1.57 children per couple where at least one marriage-mate is a college graduate. There are those who would account for the low average reproductive rate of college women by the assumption that many women have elected college and the career over the choice of marriage and family. This girl may attend *your* college but I have not found her in our institution. Without naming specific Ohio colleges which appear in this 1947 listing, it may safely be said that no college or university in our state could *maintain*, much less increase, its enrollment if it depended upon the children of its graduates.

In the peak year of 1950, the colleges of our nation graduated over 432,000 young men and women. This figure is expected to remain fairly stable through the fifties but it will rise sharply in the next decade. For the purpose of future reference, we can assume that our graduates will average 400,000 for the 1950's and these graduates will fail to replace themselves in the population by at least *one* child per graduate. A rate of reproduction which will maintain a group in the general population is an elusive figure. It is apparent that a reproductive rate of *two* children per family will not maintain due to selective losses before the children, in turn, reach the age for reproduction. Replacement figures vary from 2.1 to as high as 3.7 children per family. Since children are not born as fractions, we may state that a family of 3 children is no more than a maintenance number, especially if those children are to be subjected to the hazard of a college education. Colleges are absorbers of population, not producers of citizens for the state from which they draw their sustenance. To coin a phrase after the manner of the most eminent phrase maker of our generation, "Never have so many received so much and returned so few." Since all educational institutions receive some sort of public support we are all *state* institutions. That nebulous state contributes to education at all levels from kindergarten to graduate schools. The continuity of the state is the first duty of the citizen and the perpetuity of the intellectual elements of that state is the first duty of those with superior hereditary endowments.

The reasons for the decline of our group are beyond a full analysis in my offering but pertinent arguments may be noted. I once presented this general theme before a group of graduate students of science and received the somewhat astonishing statement that graduate students were a select group who should be removed from the drudgeries of reproduction in order to make their fullest intellectual contribution to society. This spirit of the cloister might be tolerated if it were not for the fact that we have deposited our best hereditary genes in this post-graduate section of our college population and we feel that we are entitled to a biological return on our investment.

Biological sterility among intellectuals is known but certainly the fertility of college graduates is no lower than that of our general population. I find no cause for modifying the charge which Festus hurled at Paul to read, "Much learning doth make thee *sterile*," as it is directed at our intellectual end-products.

Delayed reproduction may present problems for the obstetrician that are less likely to be encountered in younger mothers but modern medical knowledge can cope with these problems in most cases.

Social and economic factors carry much weight with all college people. The lure of the career for married graduates involves social pressures that are definitely contrary to the restrictions of home-making and family-rearing. A planned economy requires a definite budget for modern living, and the prospect of three or more children fades before the demands for better homes, better cars and the multitudinous gadgets of modern existence. Some of my critics, having harkened to the neo-Malthusian cries of Voght, Burch and other population alarmists, would say that it is folly to bring children into a world that faces the dire consequences of overpopulation. No nation, past, present or future, ever had or can have an overabundance of superior citizens. The problems of overpopulation demand superior intellects for their solution and the nation that starts a reduction program with her best stocks is more foolish than he who initiates treatments for a headache with decapitation.

I have had students respond to my pleas for survival in this fashion. "Why bring children into a mad world that is bent on destroying itself?" My answer to that question is the statement that *general acceptance* of such an attitude would destroy more potential future leaders than all the modern weapons of destruction. We are inclined to consider war as the most destructive selective force of modern times. Great Britain still mourns the loss of 400,000 of her finest young men in a six-weeks campaign in Flanders in the early part of World War I. These young men, volunteers from the colleges and the best homes of the nation, left vacancies in the leading families of the kingdom that are still felt by a nation that struggles against internal dissentions as her prestige as a world power declines. Yet when *our* college graduates fail to replace themselves by at least one child per couple, it means a loss of our nation's finest stock, not by 400,000 in one bitter contest on a foreign field of battle, but by 400,000 this year, last year, next year and annually until we convince our intellectuals that survival is of paramount importance. I repeat, no other selective factor is so fatal as not being born.

Those who are charged with the welfare of our state might well say to us, "Send these, our superior children, back to the simplicity of their village and rural homes where they will multiply and perpetuate their virtues rather than impart to them that higher education which will eliminate them from the human stream." NO! We shall not receive that charge. The children of our state will come to us and we shall teach them the glories of our literature, the truth and power of our science, the heritage of our history and their rights and privileges in a free nation. As we teach them all these good things, may we also give them by precept that which we fail to show by example—the *will* to survive.

A Physiological Approach to the Lower Animals. *J. A. Ramsay.* Cambridge University Press. 1952. ix+148 pp. $2.75.

The basic problems of function are common to all animals, but the manner in which each species solves these problems is so intimately related to body size, pattern of organization and mode of life that knowledge of mammalian physiology alone is inadequate for an understanding of the physiology of invertebrates and lower vertebrates. With this in mind, Dr. Ramsay presents some broad concepts of nutrition, circulation, respiration, excretion, muscle and nerve physiology, sense organs, coordination and behavior, these being designed to provide a background for the study of comparative physiology. The book is intended for college students with some knowledge of zoology, physics, chemistry and elementary human physiology, and they should indeed find it useful. The originality and breadth of the author's interpretations of well-known facts of physiology, however, should make it rewarding reading for any zoologist or physiologist. It is well written, and the illustrations are excellent.

W. A. Spoor.

COMPARATIVE EFFECTIVENESS OF FIVE RADIOISOTOPES AS TRACERS IN STUDYING DISPERSAL OF *CONOTRACHELUS NENUPHAR* (HBST.)

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Investigations on the field behavior of the plum curculio, *Conotrachelus nenuphar* (Hbst.), were begun in 1951 to improve some of the research techniques which are used in studies of insecticidal performance in peach orchards. There is a need not only for improvement in experimental design but also in methods of sampling populations for the evaluation of results of various treatments.

The first phase of field behavior to be studied was the movement of the adult insects after they had emerged from hibernation. In 1951 the author successfully employed radiophosphorus as a tracer to study dispersal of beetles from border rows to the center of the orchard. Nine release points were established along a row of trees bordering a woodland and radioactive insects were liberated at intervals through May and June. An attempt was made to recover the tagged insects at intervals of two to three days. Recovered insects were checked with either a portable El-Tronic Beta-Gamma Survey Meter (Model PR-3) or a Berkeley Decimal Scaler (Model 2000). Although the data from this experiment showed the general trend of dispersal, it was not possible to calculate the exact flight distances because beetles from one release point could not be distinguished from those from another point. In order to get more accurate information on flight range, it appeared desirable to use a variety of marking methods and to employ materials which could be used to designate specific locations. Accordingly, several radioisotopes and various colors of fluorescent lacquer enamels and fluorescent dusts were tested as tracers in the 1952 work.

METHODS AND MATERIALS

Two general methods were used in an attempt to feed radioactive materials to plum curculios. One method involved the feeding of radioactive solutions while the other involved feeding of fresh, radioactive plant tissue. Radioactive solutions were transferred to shell vials and stoppered with moist cotton plugs. In the late summer and fall of the year when beetles are relatively inactive, they readily ingested radioactive liquid from the moist cotton. In the spring, however, beetles are much more active and thrive better if both food and water are supplied during the activation period. Food was provided in the form of succulent peach terminals placed in small water bottles. When foliage was provided, the insects no longer visited the shell vials and therefore it became necessary to activate both the foliage and the liquid in the shell vials.

The amount of radioactivity in curculios was measured by counting the insects for 10,000 counts in a Model 2000 Berkeley Decimal Scaler having a 10 percent geometry. This number of counts allowed a probable error of only 1 percent. Curculios were placed in metal counting planchets and covered with specially constructed cages. The cages consisted of a circular ring of steel covered on top with sheer nylon. The circular rings were 5 mm. sections cut from steel pipe which measured 9 mm. on the inside diameter and 13.5 mm. on the outside diameter. These cages were designed to confine the insect to a relatively small area for counting purposes yet eliminated the possible injurious effects if anesthetization had been employed.

The thick exoskeleton of the plum curculio absorbed relatively large amounts of radiation. Tests upon radioactive insects before and after dissection and

maceration indicated that 19 percent of the strontium radiation, 35 percent of the cobalt radiation, and 39 percent of the zinc radiation were lost through self-absorption.

Preliminary activation experiments with P^{32}, S^{35}, Cl^{36}, Ca^{45}, Co^{60}, Zn^{65}, Sr^{89}, and I^{131} indicated that highly radioactive plum curculios could be produced with P^{32}, Co^{60}, and I^{131} and that fair activities could be obtained with Zn^{65} and Ca^{45}. Early tests with low activity $Sr^{89}NO_3$ killed curculios but later tests in which high activity $Sr^{89}Cl_2$ was used at low dosages gave very encouraging results. The final choice between Zn^{65} and Ca^{45} as the fifth isotope to be used was based on the fact that the radiation characteristics of Zn^{65} were sufficiently strong and considered to be significantly different from P^{32}, Co^{60}, Sr^{89}, and I^{131}. The physical characteristics and chemical forms of the five radioisotopes used in dispersal work appear in table 1.

TABLE 1

Characteristics of various radioisotopes used in activation of plum curculio.

ISOTOPE	HALF-LIFE[1]	ENERGY OF RADIATION[1] (MEV)[2]		CHEMICAL FORM
		Beta	Gamma	
Phosphorus 32	14.3 days	1.71	None	$KH_2P^{32}O_4$ $H_3P^{32}O_4$
Cobalt 60	5.3 yr.	0.31	1.10 1.30	$Co^{60}Cl_2$
Zinc 65	250 days	0.4	1.14 0.44	$Zn^{65}Cl_2$
Strontium 89	55 days	1.5	None	$Sr^{89}Cl_2$ $Sr^{89}(NO_3)_2$
Iodine 131	8 days	0.6	0.367 0.80	Elemental I^{131} in weak Na_2SO_3 solution

[1]Lapp and Andrews, *op. cit.*
[2]Million electron volts.

Radiophosphorus

Phosphorus 32 in the form of potassium acid phosphate was received as a 31 gram unit having a total activity of 350 millicuries (mc.). Since this type of P^{32} is not processed, there was considerable variation in the activity of different shipments. The salt was dissolved in distilled water and diluted to concentrations of 10 to 363μc./ml. for activation experiments.

Processed phosphorus was used only in preliminary work because of its relatively high cost. This material was received as orthophosphoric acid having a concentration of 3.87 mc./ml. on October 23, 1950. In exploratory studies this material was diluted to concentrations of 1, 2, 5, and 10 μc./ml.

Radiocobalt

Cobalt 60 was received as cobalt chloride in acid solution having an original concentration of 34.2 mc./ml. $\pm$3 percent. This material had a specific activity of 4,816 mc./gm. In preliminary work Co^{60} solutions were diluted to concentrations of 5.5, 11, 22 and 44 μc./ml. Later concentrations of 50 to 100 μc./ml. were used successfully in producing high activities in adult insects.

Radiozinc

Zinc 65 was obtained as zinc chloride in acid solution having an original concentration of 3.14 mc./ml. $\pm$ 10 percent on April 11, 1952. The specific activity of this material was quite low (28 mc./gm.) as compared with other radioisotopes used

in these experiments. Zn^{65} was used at concentrations of 2, 4, 8, 16, 22, 44 and 290 μc./ml.

Radiostrontium

Strontium 89 was received in two distinct forms and these varied widely in specific activity. One unit of Sr^{89} in the form of strontium nitrate with a total activity of approximately 1.5 mc. was received on August 16, 1951. The other shipment of strontium consisted of 31.3 ml. of carrier free $Sr^{89}Cl_2$ in acid solution having a concentration of 1.60 mc./ml. ± 10 percent. This material was employed at concentrations of 0.375 to 20 μc./ml.

Radioiodine

Iodine 131 was received as a 50.435 mc. carrier free unit having a concentration of 9.17 mc./ml. ± 10 percent. A concentration range of from 8 to 75 μc./ml. was used in preliminary activation tests.

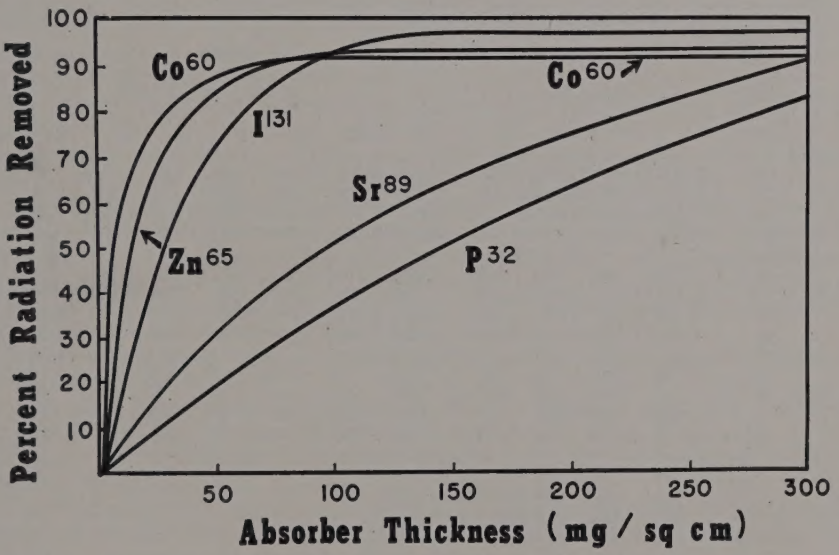

FIGURE 1. Absorption curves for various radioisotopes used to activate plum curculio.

Release and Recovery

Adult plum curculios which had been collected from unsprayed peach and plum trees were fed $KH_2P^{32}O_4$, $Co^{60}Cl_2$, $Zn^{65}Cl_2$, $Sr^{89}Cl_2$, and elemental I^{131} in solution or in peach foliage. Each of these materials was used to designate one of the five different release points.

Releases were made simultaneously at each release point at weekly intervals from May 12 to June 15. Activated insects were released at the base of the release trees in early morning or after sundown. Recoveries were made by jarring all of the peach trees in the orchard at three to four day intervals from May 22 to June 25.

Beetles which were collected in this manner from release trees were checked for radioactivity with an El-Tronic portable beta-gamma survey meter. Individuals showing activity were recorded and released with the assumption that the identity of the radioisotope in the insect corresponded with that of the release point.

Plum curculios which were recovered after they had flown at least 25 ft. from the point of liberation were brought into the laboratory and measured for radio-

activity in a Berkeley Decimal Scaler. Radioactive insects were then killed and cemented to the bottom of a metal counting planchet. Next an attempt was made to determine the point of release by identifying the radioisotope present in the insect on the basis of its radiation characteristics. First, the relative energy of the radiation was determined by means of a graduated series of aluminum foil absorber screens. Absorption curves were then prepared and in this manner the pure beta emitting materials could be separated from the beta-gamma emitting materials. Absorption curves for five radioactive materials used in these experiments are shown in figure 1. The curves for pure beta emitters such as Sr^{89} and P^{32} are shown to be only slightly curved while the curves for the materials emitting both beta and gamma radiation are true exponential curves. Counts were made at 14-day intervals for half-life determinations.

TABLE 2

Degree and persistence of radioactivity of ingested radiophosphorus, radiocobalt, radiozinc and radiostrontium in adult plum curculios. Figures in body of table refer to counts per minute.

Isotope	Concentration (μc/ml)	Days after Initial Exposure											
		Activation Period				Retention Period							
		1	2	3	4	15	30	45	60	75	90	105	120
P^{32}	10	5,200	17,900	20,200	20,700	12,000	3,900	1,040	350	150	74	41	0
	25	5,300	17,900	20,300	22,300	13,400	5,000	1,500	480	194	104	65	46
	50	15,500	35,400	40,500	48,700	30,000	8,600	2,080	665	290	154	92	56
	100	26,700	50,900	58,500	64,000	44,000	13,000	3,000	1,100	440	200	106	66
Co^{60}	5.5	30	50	100	1,900	1,400	760	580	310	215	155	128	118
	11	135	1,600	2,300	2,500	1,700	900	465	300	200	140	110	100
	22	1,000	3,000	3,900	5,500	5,000	4,200	3,650	2,750	2,370	2,100	1,950	1,900
	44	1,400	4,200	6,400	6,600	6,000	3,500	2,000	1,350	1,000	940	900	880
Zn^{65}	2	22	37	24	131	78	0	0	0	0	0	0	0
	4	25	97	115	293	130	62	41	0	0	0	0	0
	8	36	89	229	337	220	135	86	58	45	38	35	0
	16	75	172	264	415	240	130	80	62	54	52	50	48
Sr^{89}	0.375	24	67	1,156 Beetles dead									
	0.75	24	901	998 Beetles dead									
	1.5	366	523	714 Beetles dead									
	3.0	289	502	561 Beetles dead									

RESULTS

In radiophosphorus activation experiments with solutions, a concentration range of from 1 to 363 μc./ml. was tested over a two year period. The most practical dosage when using shell vials appeared to be around 100 μc./ml. Plum curculio adults exposed to this concentration of P^{32} for 2 days averaged approximately 50,000 counts per minute (cpm.). The amount of radioactivity produced by ingesting various levels of radiophosphorus and the retention of this radioactivity is shown in table 2. It is evident that curculios reach relatively high levels of activity in two or three days. The figures in table 2 indicate that about 30 percent of the maximum activity is reached in the first day, 80 percent the second day, 90 percent the third day, and approximately 100 percent the fourth day. A saturation level of activity was reached on the fourth day. These data are based upon tests conducted from August 21 to December 17, 1951. In the spring of the year when physiological processes in the beetles are more rapid, the retention period of radiophosphorus is probably greatly reduced. When the concentration of P^{32} is increased, a given activity is reached in a shorter time but concentrations in the range of 350 μc./ml. proved to be toxic to adults.

When peach foliage was employed to activate beetles, concentrations of from 10 to 122 μc./ml. were tested. The lower ranges resulted in activities of from 1,900 to 10,000 cpm. per beetle in 5 days as compared with an activity of 14,000 cpm. in the upper ranges. The optium concentration in solution was considered to be approximatley 100 μc./ml. At this strength beetles reached high activities in 4 to 5 days.

Radiocobalt was the most persistent of the five radioisotopes tested and therefore lends itself particularly well to long range studies. The degree and persistence of ingested radiocobalt at low concentrations is summarized in table 2. In comparison with radiophosphorus the activation of insects with radiocobalt was much slower since by the end of the second day an average of less than 50 percent of the maximum activity was reached. Later and more comprehensive experiments carried on in the spring of 1952 showed that a radiocobalt chloride solution at a concentration of 100 μc./ml. gave high and more rapid activation. Beetles feeding upon these solutions averaged about 12,000 cpm. in 5 days. Attempts to activate peach foliage with Co^{60} solutions were unsuccessful.

In the fall of 1951 Co^{60} solutions with concentrations of 5.5, 11, 22, and 44 μc./ml. were compared. Four days after exposure the respective activities of the insects were 1,900 2,500, 5,500, and 6,600 cpm.

Preliminary tests with Zn^{65} at concentrations of 2, 4, 8, and 16 μc./ml. indicated that much higher ranges would be needed for field recoveries. Accordingly, the concentration was raised to 290 μc./ml. but this concentration proved toxic to beetles. When the activity of the radioactive solution was increased to 44 μc./ml. succulent peach foliage was killed very rapidly. This was undoubtedly due to the toxic effects of the non-radioactive carrier zinc in solution. When this solution was reduced to half strength, fair activities were obtained in feeding beetles upon activated foliage. A group of 21 insects which had fed upon activated foliage at the above concentration averaged 758 cpm. This material was the least effective of the five radioactive materials employed in feeding tests.

Initial experiments with radiostrontium were carried on with $Sr^{89}(NO_3)_2$ at concentrations of 0.375, 0.75, 1.5, and 3 μc./ml. Table 2 shows that after curculios had reached an activation of several hundred cpm. they exhibited symptoms of poisoning and died within a few days. Later tests with the non-radioactive salt $Sr^{89}(NO_3)_2$ proved that typical symptoms of poisoning were produced by chemical, rather than radiation, effects.

The following year solutions of $Sr^{89}Cl_2$ of high specific activity and comparatively low chemical concentrations were used successfully in both foliage and vials. Relatively low levels of activity of $Sr^{89}Cl_2$ were needed to produce high activity in the plum curculio. The optium concentration was approximately 2 μc. ml. in vials and 20 μc./ml. in foliage.

Radioiodine was employed in concentrations of 8, 32, 40, and 75 μc./ml. in activation work. At the higher concentrations beetles after five days exposure averaged 26,864 cpm. while at lower levels they averaged 2,680 cpm. I^{131}, like Co^{60}, was not readily taken up by peach foliage and therefore aqueous solutions in vials were used in all activation work.

DISCUSSION

A total of 473 beetles were activated and released and 193 recoveries were made. Release points were determined for 93 percent of the beetles which were recovered at various points in the orchard. Table 3 shows the number of beetles released, the number of beetles recovered, and the average flight distance.

Thirty-one beetles were recovered on trees exclusive of release trees. No recoveries were made of insects activated with radioiodine on other than the release trees. This was believed to have been due to the short half-life of I^{131}.

There was considerable variation in the average and maximum flight distance of curculios activated with different isotopes. Although the numbers recovered were

comparatively small, there was some indication that materials with half-lives comparable to P^{32} or shorter may be too short lived for this particular type of field investigation. Since soil contamination is not a problem with the small amounts of radioactive material employed in such studies it would seem desirable to employ those isotopes, such as Sr^{89} and Co^{60} which have relatively long half-lives for field behavior investigations extending over a period of 6 to 8 weeks. However, the hazard involved in fruit contamination must also be taken into consideration.

TABLE 3

Release, recovery and flight distance of plum curculios marked with various radioisotopes.

Radioisotopes	No. Beetles Released	No. Beetles Recovered	Average Flight Distance in ft.	Maximum Flight Distance in ft.
P^{32}	62	49	61.2	90
Co^{60}	127	50	82.7	870
Zn^{65}	23	7	82.5	135
Sr^{89}	175	70	135.8	403
I^{131}	86	17	0	0
Totals	473	193		

CONCLUSIONS

It may be concluded from these experiments that it is possible to activate plum curculios with any of the five radiosotopes. There is, however, considerable variation in the rate of uptake and in the length of time the materials are retained by adults. Sr^{89} appeared to be the most useful radioisotope for these studies since it can be presented to insects in either solutions or in plant tissue, it has a relatively long half-life, and the radiation is comparatively strong. It is a pure beta emitter and hence is less hazardous than gamma emitting substances. The chief danger in the use of strontium is the possible accumulation of this element in bone tissue of those handling it through accidental inhalation or ingestion.

Co^{60} was also a very effective and persistent tagging agent. The only disadvantages are that it is a gamma emitter and it is not well distributed in plant tissues. Cobalt was retained longer than any of the other isotopes which were employed in field work.

P^{32} has all the advantages of Sr^{89} and in addition is much less hazardous to the investigator. Its relatively short half-life may limit its usefulness in the field except in certain instances where insects can be fed for relatively long periods so that a large quantity of the material is present in the insect tissue.

Zn^{65} was not very satisfactory because of the low specific activity of the sample employed. Radiozinc may prove to be most useful when used as a high specific activity material either in solution or in topical application with adhesive preparations. I^{131} was quite unsatisfactory because of its very short half-life.

These experiments have shown that it is possible to mark insects with several different radioisotopes, release them simultaneously in the field, and later identify the isotope with which recoveries were activated. However, for this particular problem the use of these particular radioisotopes was impractical because it required such a long time for half-life determinations. In certain types of experiments where half-life determinations can be made at the convenience of the investigator, the use of Sr^{89}, P^{32}, and Co^{60} should prove to be quite practical and useful in designating different release points or release dates.

LITERATURE CITED

Lapp, R. E., and **H. L. Andrews.** 1948. Nuclear radiation physics. Prentice-Hall, Inc. New York. 487 pp.

INVERTASE ACTIVITY IN ADULT *AEDES AEGYPTI* MOSQUITOES

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In connection with studies of proteolytic digestion in the *Aedes aegypti* msoquito (Fisk, 1950; Fisk and Shambaugh, 1952; Shambaugh, 1954) a technique was devised for measuring the activity of invertases and amylases in adult mosquitoes. The results of this study are reported here.

As is well known, most adult female mosquitoes feed primarily on blood, which is taken directly into the midgut, and secondarily on nectar, exposed fruit juices or other sweetened liquids, which pass first to the diverticula for temporary storage and then, gradually, back through the midgut. The small paired dorsal diverticula and the larger ventral diverticulum or crop are all blind tubes consisting of thin transparent sacs covered with a syncitium of muscles sufficient to provide a high degree of elasticity and some mobility. No secretory epithelium has been found, so that any digestive enzymes noted in the diverticula are presumed to have been secreted elsewhere.

METHODS

The methods of securing, feeding, incubating, dissecting, and preparing homogenates from adult female *Aedes aegypti* mosquitoes have already been adequately described (Fisk and Shambaugh, 1952). The methods of enzyme analysis for invertases or amylases were identical except for substrate and employed a modification of the 3,5-dinitrosalicylic acid technique of Sumner (1925). This is a colorimetric test for reducing sugars which has been shown by Walker and Reisinger (1933) to detect as low as one microgram of reducing sugars in a 0.2 μl. sample of glomerular urine. This corresponds to a 0.5 percent concentration of reducing substances. With larger samples, more dilute solutions can be determined.

The dinitrosalicylic acid reagent, which remained useful for a month or more in a refrigerated, glass-stoppered bottle, was prepared as follows: Ten grams crystallized phenol was added to 22 ml. 10 percent NaOH and diluted with water to 100 ml. Sixty-nine milliliters of this alkaline phenol solution was then added to 6.9 g. $NaHSO_3$, 300 ml. 4.5 percent NaOH, 255 g. Rochelle salts, and 880 ml. 1 percent 3,5-dinitrosalicylic acid.

Invertase determinations were made in the following manner: The dissected viscera were removed from the deep-freezer, homogenized in Levy's saline, and diluted with saline to 1.6 ml. Three 0.5 ml. aliquots were taken from the homogenate, one being placed in a boiling water bath, and the other two in the deep-freezer. After 5 min. the aliquot was removed from the water bath and placed in the deep-freezer with the others for 5 min. Then the substrate, 0.5 ml. 2.5 percent sucrose in a phosphate buffer of pH 6.5, was added and stirred. The brei was incubated an hour at 35° C. Incubation was stopped by emptying the brei into a tube containing 2 ml. of dinitrosalicylic reagent and placing it in a boiling water bath for 5 min. At the same time a reagent blank prepared from 1 ml. water and 2 ml. reagent was given the same treatment. All the tubes were then cooled 3 min. in running water. Aliquots of 0.5 ml. were diluted to 10 ml. and read in a Klett-Summerson photo-electric colorimeter using the green (540 mμ) filter.

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Amylase determinations were made in the same manner, but with a change of substrate to 0.5 ml. portions of 1.5 percent soluble starch plus 0.5 ml. phosphate buffer, pH 6.5.

RESULTS AND DISCUSSION

The three possible sources of digestive enzymes considered were the salivary glands, the diverticula (including the crop), and the midgut. Metcalf (1945) found amylase, protease, and lipase to be absent from the salivary glands of *Anopheles quadrimaculatus*. Our preliminary tests showed invertase to be absent from the salivary glands, but present in both midgut and crop homogenates. Separate invertase determinations were then made for midgut and diverticula tissues from blood-fed and from sugar-fed mosquitoes. The results of these four series of tests are shown in table 1.

TABLE 1

Comparative invertase activities, expressed in colorimeter units, of diverticula and midgut homogenates respectively from blood-fed and from 5% sucrose-fed female **Aedes aegypti.**

Interval of Time After Feeding	Blood-fed Mosquitoes†		5% Sucrose-fed Mosquitoes	
	Diverticula	Midguts	Diverticula	Midguts
Unfed	70 (3)	108 (2)	70 (3)	108 (2)
½ hr.	75 (2)	224 (2)	20 (2)	85 (2)
1 hr.	64 (3)	155 (3)	33 (2)	108 (4)
2 hr.	24 (1)	335 (1)	34 (2)	106 (2)
4 hr.	(0)	99 (1)	36 (3)	92 (2)
8 hr.	35 (1)	131 (1)	14 (2)	102 (2)
12 hr.	58 (1)	116 (1)	18 (2)	93 (2)
24 hr.	40 (2)	125 (2)	27 (1)	84 (1)

†The values given are averages of the number of tests indicated in parenthesis, each test consisting of duplicate runs and a boiled blank on material from 20 mosquitoes.

Tests for amylase run on single homogenates of salivary glands, diverticula, and midguts of unfed mosquitoes were all negative. Although further tests were not run, it is possible that significant amylase activity could be demonstrated in crops or midguts of blood-fed mosquitoes.

The data in table 1 indicate appreciable amounts of invertase in both midguts and diverticula of unfed or starved mosquitoes. This residual activity is lower for the diverticula and remains so following feeding, in fact it decreases within half an hour following a syrup meal and within two hours after a blood meal. The comparatively rapid decrease after sugar feeding is probably due to a depletion of the enzyme by its substrate, as described by Day and Powning (1949) for the roach, but the same explanation cannot apply to the apparent decrease after a blood meal since the blood is not found in the diverticula nor does it contain a substrate for invertase.

Invertase activity in the midguts shows a definite increase following a blood meal. This stimulation, the greatest shown in any of the tests reported in this paper, lasts somewhere between two and four hours, a short time compared to the protease stimulation after a blood meal which is at its peak at about 18 hr. after feeding (Fisk and Shambaugh, 1952). After a meal of 5 percent sucrose, invertase activity in the midguts shows little change. If the small differences shown for this series in table 1 can be interpreted as indicative of actual trends, they would show an initial depletion (similar to that noted in the diverticula under the same circum-

stances), followed by a slight increased activity past the two hour interval then a return to the residual value.

The stimulation of invertase activity in *Aedes aegypti* stands in contrast to the stimulation of protease in the same species. Invertase activity is stimulated very little by its proper substrate, sucrose, but very definitely by that primary foodstuff of the female mosquito, blood. Protease activity was found to be stimulated profoundly by its proper substrate, blood, but only briefly and in small amount by sugar syrup. It is apparent that secretions of both invertase and protease are stimulated by factors, possibly identical factors, in the blood meal.

SUMMARY

A quantitative colorimetric method is described whereby the invertase or amylase activities of insect tissues homogenates can be determined. The technique measures microgram quantities of reducing sugars, using a 3,5-dinitrosalicylic acid reagent.

Tests with unfed female *Aedes aegypti* mosquitoes gave negative results for amylase in the midguts, and diverticula and salivary glands and for invertase in the salivary glands. Significant invertase activity was found in midgut and diverticula tissues of unfed or starved individuals.

Determinations were run comparing the invertase activities of midguts and diverticula at various intervals after feeding on blood or on 5 percent sucrose.

At all intervals tested, invertase activity was highest in the midgut tissues, agreeing with morphological evidence that the enzyme is secreted in the midgut, not the diverticula.

Definite increases in invertase activity of less than four hours duration occurred in the midgut following blood-feeding, while the changes following sucrose feeding were relatively slight.

The diverticula, on the other hand, showed decreases in activity following the feeding of either food.

LITERATURE CITED

Day, M. F., and **R. F. Powning.** 1949. A study of the processes of digestion in certain insects. Austral. Jour. Sci. Res., Ser. B. 2: 175–215.

Fisk, F. W., and **G. F. Shambaugh.** 1952. Protease activity in adult *Aedes aegypti* mosquitoes as related to feeding. Ohio Jour. Sci. 52: 80–88.

Metcalf, R. L. 1945. The physiology of the salivary glands of *Anopheles quadrimaculatus*. Jour. Natl. Malaria Soc. 4: 271–278.

Shambaugh, G. F. 1954. Protease stimulation by foods in adult *Aedes aegypti* Linn. Ohio Jour. Sci. 54: 151–160.

Sumner, J. B. 1925. A more specific reagent for the determination of sugar in urine. Jour. Biol. Chem. 65: 393–395.

Walker, A. M., and **J. A. Reisinger.** 1933. Quantitative studies of the composition of glomerular urine. IX. The concentration of reducing substances in glomerular urine from frogs and necturi determined by an ultramicroadaptation of the method of Sumner. Observations on the action of phlorhizin. Jour. Biol. Chem. 101: 223–237.

The Science Book of Wonder Drugs. *Donald G. Cooley.* Cardinal Edition, Pocket Books Inc., New York. 1954. 238 pp. $0.35.

The book is written in a clear and easy to read style, and would be of especial benefit to the layman or others with little biological background. The drugs and other materials discussed are chiefly those which have been discovered or employed in medicine since 1935 and include the following: sulfas, antibiotics, the "wonder" hormones, enzymes, antihistamines, and several other groups of lesser importance. Other chapters deal with bacteria, viruses, and cancer. Simple explanations are presented in discussing various modes of action of the drugs such as the competitive inhibition of enzyme systems. Several diagrams and tables are included.

JAMES N. LILES

DELETION OF THE SYSTEMIC ARCHES AND EVOLUTION OF THE AORTIC ARCH SYSTEM IN BIRDS

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Evolution of the aortic arch system has been one of progressive deletion and substitution, accompanied by a reorientation or rerouting of the blood supply. The greatest changes in the system occurred in the transition from the holoaquatic to the terrestrial habit, with deletion of the first, second, and finally the fifth pairs of arches. Associated with these deletions, and the development of the pulmonary circulation, was reduction and atrophy of the dorsal portion of the sixth arches.

Subsequently, evolution of the system has resulted in atrophy of one of the radices aortae (left in birds and right in mammals), loss of the left systemic arch in birds, and loss or functional modification of the right systemic arch in mammals.

Still further changes and deletions in this system are found to occur in the birds. Of very common occurrence is reduction or loss of the dorsal portion of either the left or right 3rd aortic arch, accompanied by fusion of the dorsal carotids, anterior to the carotid arch (unicarotid condition). In a few instances, however, both left and right dorsal carotids become reduced to ligamentous vestiges (ligamenti ottleyi) and cephalic blood flow is carried by the vertebral and superficial cervical arteries. In such instances, the dorsal portions of both left and right carotid arches become obliterated.

With loss of the left systemic arch, the left ductus caroticus loses its posterior connection, and usually becomes functionally modified. In most instances this is followed by a similar disconnection of the right ductus caroticus. The latter, however, frequently retains its connection between the carotid and systemic arches and remains as a patent vessel.

Recent studies on 810 species and subspecies of birds have revealed the following, rather interesting, fact. In a single specimen of *Megapodius freycinet layardi*, and over 30 specimens of the Trochilidae, both left and right systemic (4th aortic) arches were lacking. In each of these instances, it was apparent that the right ductus caroticus remained as the functional systemic arch which carried the blood supply to the abdominal aorta. Such a condition is not to be regarded as totally unexpected in the course of evolution of the aortic arch system, although it has not, to the writer's knowledge, been reported previously.

The particular significance of the occurrence of this reduction in *Megapodius* and among the Trochilidae cannot be satisfactorily evaluated at this time. It seems to me to be significant that the Trochilidae appear to present a highly uniform occurrence in the deletion of the right systemic arch, particularly in view of their rather restricted distribution. Evolution of this family of birds probably centered in South America, after an earlier origin from the common Apode stock in Antarctica.

Insular isolation of *Megapodius layardi* may have been a factor contributing to the evolution and deletion of the right systemic arch in this specimen. It has not, however, been ascertained to what extent this deletion may occur in this species, but further studies might reveal the expected frequency of occurrence.

In conclusion, it may be expected that, in the course of evolution of the aortic arch system of birds, only the proximal or ventral portions of the 3rd aortic (carotid) and 6th aortic (pulmonary) arches and the right ductus caroticus will remain as the functional portions of the embryonic aortic arch system. The major cephalic blood supply will then be carried by the vertebral and superficial cervical arteries, while the blood supply to the abdominal region will be carried by the ductus caroticus and abdominal aorta.

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AN UNUSUAL PEARL FROM A FRESHWATER MUSSEL AND A PEARL-LIKE GROWTH FROM A CRAYFISH

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In the study and dissection of invertebrate animals used for laboratory teaching of zoology over the past twelve years, two unusual specimens were discovered which are worthy of note. One was the shell of a freshwater mussel with a large pearl imbedded within the valve, and the other was a crayfish with a cyst-like growth on the carapace which contained a laminated body resembling a pearl in its manner of formation. These are described below.

In the winter of 1946 a student discovered immediately upon opening a freshwater mussel that it contained a large pearl. It was almost completely enveloped by a pocket formed at the edge of the mantle and was half-sunken within a cavity of the shell. The mussel was a 11.5 cm. specimen of *Amblema costata* Raf. which had been collected from the vicinity of Oshkosh, Wisconsin. The pearl was not perfectly spherical, but was nearly so. Its greatest diameter was 6.33 mm. and it weighed 308.8 mg. The surface finish was satiny-white but not of bright lustre, probably because of the acid reaction of the formaldehyde in which the mussel had been preserved.

Kunz (1898) described and figured a freshwater pearl similar to the one reported here. However, his specimen was nearly hemispherical in shape, presumably because it had been pressed into the nacre. Kunz (1898) wrote that "pearls are sometimes imbedded in the shell or growing so as to form a socket in it; this fact is well known, though of rare occurrence." Another hemispherical pearl within a cavity was reported by Hodgson (1902).

Blister pearls and various pustules or concretions are common on the nacre of many species of freshwater bivalves. When perfect pearls are found they are usually enclosed within the mantle and have no contact with the valves. It is unusual to find a nearly spherical pearl imbedded within a cavity of the nacre and apparently the specimen described here is the first of its kind to be reported. X-ray pictures taken of the pearl, ranging from 32Kv. for 0.1 sec. to 64Kv. for 0.75 sec., failed to disclose any discernible nucleus.

While distributing crayfish to a zoology class in 1950, the writer discovered one with a conspicuous cyst-like growth on the side of the carapace. It was a specimen of *Orconectes propinquus* (Girard), commonly known as *Cambarus propinquus* Girard, from a shipment which had been collected from shallow waters of Lake Michigan near Green Bay, Wisconsin. This crayfish was a male specimen 85 mm. in total length from the tip of the rostrum to the end of the telson. The anomalous growth, situated 2 mm. from the posterior margin of the carapace on the right side, measured 12.0 mm. long, 8.0 mm. wide, and 6.0 mm. high (fig. 1). Upon dissection there was found inside a rubbery mass 9.5 x 6.0 x 2.5 mm.

Possibly a foreign body was in some way thrust under the carapace at or about the time of molting and caused the flexible carapace to bulge at that point, eventually forming a cyst-like growth around it. It is known that some parasitic organisms such as certain trematodes, copepods, and bopryid isopods and some commensals such as certain branchiobdellid oligochaetes and ostracods infest the gills of crayfish. While it is possible that such an organism might have formed the nucleus which produced the anomalous growth, no trace of an organism could be detected by either gross or microscopic sectioning. A central homogeneous mass was enveloped by successive layers, each consisting of compact columnar

units. Histochemical tests (Gomori, 1952) made by Dr. Elizabeth Smith indicate that the object is apparently composed of chitin. It appears, then, that a foreign body was accidentally introduced under the lining of the carapace which stimulated the deposition of laminations of chitin about it much as a pearl is produced by a bivalve. This pearl-like growth in turn caused the hypodermis of the carapace to form a cyst-like wall about it. No similar case has been found in the literature.

Acknowledgment is made to Dr. Elizabeth Smith for making the histochemical tests, to Dr. Emanuel Hertzler for preparation of the stained slides, to Miss Catherine Baker for making X-ray pictures, to Robert Burrs for the photograph of the crayfish, and to Pres. Blair Coursen of the General Biological Supply House for tracing the source of the specimens which had been purchased from that organization.

FIGURE 1. Specimen of *Orconectes propinquus* showing growth on carapace which contained a foreign body of pearl-like formation.

LITERATURE CITED

Gomori, G. 1952. Microscopic histochemistry. The University of Chicago Press.
Hodgson, C. S. 1902. A large pearl. Nautilus 16: 60.
Kunz, G. F. 1898. The freshwater pearls and pearl fisheries of the United States. Bull. U. S. Fish Comm. (for 1897), 17: 375–426.

SOME EOCENE DICOTYLEDONOUS WOODS FROM EDEN VALLEY, WYOMING

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The present study is concerned with the description and identification of approximately one hundred silicified wood specimens. All were originally collected by Mr. Sharpe Osmundson of Council Bluffs, Iowa, and subsequently secured by Mrs. Elizabeth Dalve of Cincinnati who kindly presented the material to the Paleobotanical Laboratory of the Botany Department of the University of Cincinnati for study.

The specimens were picked up on the surface on private property known as Hays' Ranch, being reached by state route 28, about 16 miles east of Farson, Wyoming. Physiographically, the site lies within the Eden Valley, a moderate-sized structural basin drained by a few small streams which are tributary to the Green River.

The geologic strata of the region have been described as flat-lying and consisting of interbedded sandstone, shale, and siltstone. The highest concentration of fossil wood occurs within the sandstone which crops out as low ledges. Even though the specimens were picked up on the surface, it is probable that they were preserved *in situ* and their appearance is the result of weathering in place and not the result of transport from other localities. The surface rocks of this locality belong to the Green River Formation, or possibly the upper Wasatch, thus making the age of the forest upper Lower Eocene.

All slides were prepared by the standard thin-section method since peels were not practicable with the material.

In describing the specimens, the outline suggested by Record and Chattaway (1939) was followed. It soon became evident that because of the varying states of preservation of the fossils, many of the criteria used for determination of modern woods were not applicable.

Two approaches were employed for purposes of identification with varying degrees of success. First, by a comparison of the material with descriptions in the standard references of Metcalfe and Chalk (1950) and Record and Hess (1943), family after family was eliminated. When similarities existed, comparisons among the genera were made. Finally, the material was compared with various modern species of these genera. In the second approach to identification, the fossil record, particularly the compression material of comparable age and locality, was examined. Modern representatives of many of these were then compared with the specimens.

Keys to modern woods are difficult to use as most are prone to use such characteristics as color, odor, or taste, all of which, of course, are meaningless for study of fossil woods. At all times it was necessary to keep in mind that most of the fossil specimens were twigs or possibly rootlets and that most modern descriptions are based on mature wood. Size of elements then becomes an important consideration. Finally, it may be mentioned that many specimens were found that had well-preserved tissues such as pith, phloem, and periderm in addition to the secondary xylem. These tissues were of little help in identification, although they are of considerable botanical interest.

DESCRIPTIONS OF SPECIES

Order: MYRICALES
Family: MYRICACEAE

Myrica scalariformis, sp. nov.
(fig. 1, 2, 3)

Growth rings: indistinct; possibly as many as 10 in the specimen (diameter of specimen 29 mm., center very eccentric).

Vessels: typically diffuse porous; pores virtually all solitary, occasionally in multiples of two, evenly distributed, more or less circular, average diameter 70 μ; average vessel member length 600 μ; 40 to 60 pores per sq. mm.; thick-walled, large tyloses apparently present in some vessels; perforation plates scalariform, frequently reticulated, long, up to 35 or 40 bars; bars about as wide as the spaces; plates very steeply inclined from the horizontal; intervascular pitting opposite in 4 or 5 vertical rows; borders circular, about 5 μ in diameter; inner apertures included, lenticular, about half as long as diameter of border, with tendency to horizontal orientations; apertures of pit-pairs apparently not crossed; vessel to ray pitting fine, opposite, half bordered, borders on vessel side essentially circular, about 3.5 μ in diameter; inner apertures lenticular, oriented horizontally, nearly as long as diameter of border; 12 to 15 pits per cross-field.

Wood parenchyma: fairly abundant, in long strands, arrangement not determinable, but probably diffuse or a few strands in groups.

Rays: strikingly heterogeneous, bi- or triseriate, mostly the former, with uniseriate margins of 1 to occasionally 5 cells; height 140 to 430 μ (3 to 20 cells, averaging 15), width less than 35 μ; marginal cells square or slightly upright, cells in interior of ray mostly procumbent with occasional tiers of square or upright cells interspersed between the procumbent tiers; occasional low uniseriate rays of upright cells; most of the multiseriate rays with large, storage-type cells which are either procumbent, square, or upright and which occupy the entire width of the ray.

Fibers: moderately thick-walled (4.4 μ); diameter variable, 8 to 18 μ, length 280 to 550 μ; ends somewhat rounded; pits distinctly bordered, in one or occasionally two vertical rows; borders circular, about 5 μ in diameter; inner apertures slit-like, included, extending nearly to the border, orientation nearly vertical; apertures of pit-pairs crossed at a small angle.

Pith: very small; character of cells not determined. (The possibility remains that a pith is absent and that this specimen may be a root.)

Type specimen and slides: No. B-3302 of the Paleobotanical Collection of the University of Cincinnati.

DISCUSSION

Lesquereux in his Green River Flora (1883) lists 20 species of *Myrica* based on compression material and Berry in his work on the Wilcox Flora (1916) lists two species of leaf compressions of the same genus. Comparing the specimen with a prepared slide of the mature wood of *Myrica cerifera* L., a striking similarity was noted, particularly in the pore arrangement and in the rays as viewed in tangential section. Some minor differences, however, were noted as follows: (1) The rays in the fossil are mostly biseriate, but occasionally triseriate, while in *M. cerifera* the reverse is the case. (2) Storage-type cells (oil cells) are absent in *M. certifera*, but are present in the fossil. (3) The intervascular pitting is scalariform in *M. cerifera*, but opposite in the fossil.

It is evident that this specimen is not *M. cerifera*, but it will be noted that in every case in which there is a difference, the fossil wood deviates in no way from the general description of the genus. The very distinct scalariform perforations of the vessels as seen in radial section (fig. 2) suggested the specific epithet.

Compressions of leaves, flowers, and seeds of *Myrica* are abundant in the fossil record throughout every period from the Cretaceous to the present; in fact, more fossil species have been described than there are modern species. For North America alone, Knowlton (1919) lists 63 valid species and to this La Motte (1944) adds 24 additional species or varieties. Lesquereux (1883) described two species from the Dakota Group of Cretaceous age from Kansas. In his original

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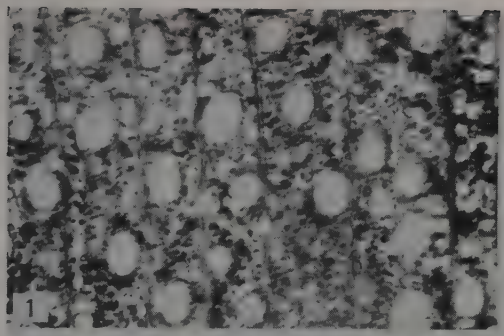
EXPLANATION OF FIGURES IN PLATE I

FIGURES 1–3. *Myrica scalariformis*, × 80. 1—transverse section; 2—radial section; 3—tangential section.

FIGURES 4–6. *Talauma multiperforata*, × 80. 4—transverse section; 5—tangential section; 6—radial section.

FIGURES 7 and 8. *Forchhamerioxylon scleroticum*, × 32. 7—transverse section; 8—tangential section.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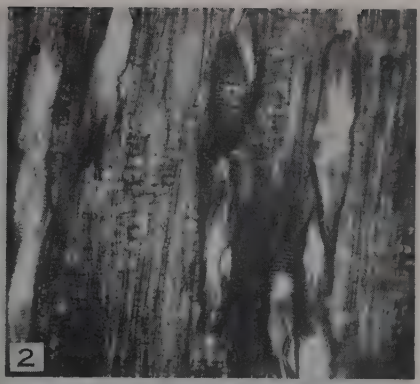
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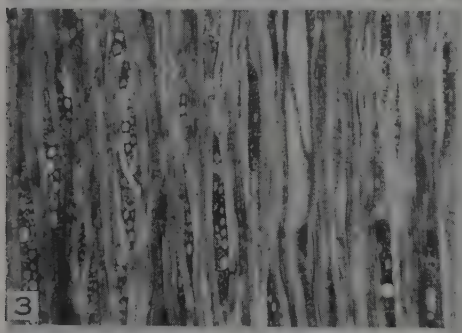
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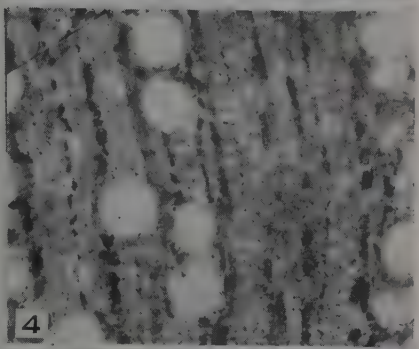
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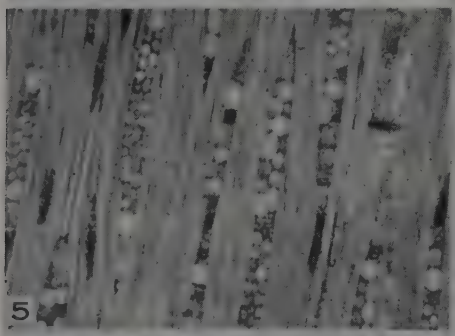
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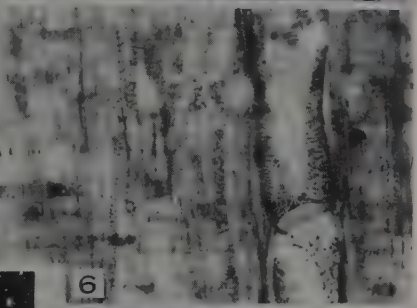
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work on the Green River Flora, Lesquereux (op. cit.) lists 20 species, 11 of which are described in detail. Brown (1934), however, referred 6 of Lesquereux's species to other genera. Berry (1916) in his original work on the Wilcox Flora, described two species and to this he later added one more (1930a). In Europe, the genus is represented from the Oligocene to the present. As far as the author could ascertain, the fossil wood of *Myrica* has not previously been described.

The geographic distribution of the genus as a fossil is quite extensive in North America. It extends from Massachusetts southward along the Atlantic coast to Florida, thence westward as a very wide band, the southern limit of which is the Gulf of Mexico and the southern boundary of the United States, to the west coast. The northern limit in the United States passes through Maryland, Kentucky, Nebraska, Wyoming, to the Pacific in Oregon. Northward it has been found in a wide band passing through British Columbia and Saskatchewan, the Northwest Territory on into Alaska.

At present the genus is found throughout the temperate and tropical regions of both the Eastern and Western Hemispheres. In North America the northern limit extends as a line from Labrador to Minnesota, into Saskatchewan.

Order: RANALES
Family: MAGNOLIACEAE

Talauma multiperforata, sp. nov.
(fig. 4, 5, 6)

Growth rings: fairly distinct; five in specimen, 1 to 2 mm. wide. (Diameter of specimen about 16 mm.)

Vessels: diffuse porous to semi-ring porous; pores solitary and in radial multiples of 2 to 4, essentially circular except for flattening along line of contact between pores ot multiples, 56 to 126 μ in diameter, averaging 96 μ, 30 to 40 per sq. mm.; vessel member length 350 to 500 μ; tyloses not observed; perforations scalariform with many narrow bars to occasionally simple; plates inclined about 45 degrees toward rays; intervascular pitting scalariform to occasionally opposite; pits about 8 μ apart; vessel to ray pitting not observed.

Wood parenchyma: not observable in the specimen.

Rays: heterogeneous, bi- or triseriate with 1 to 4 rows of marginal cells which are large and greatly elongated vertically; cells of uniseriate parts of multiseriate rays in the interior of the ray are similar to the marginals; other cells of rays square or slightly procumbent; uniseriates rare and entirely of upright cells; height 8 to 42 cells, maximum 1.5 mm.; maximum width 63 μ; about 10 rays per mm. as measured on the tangential surface; rounded storage-type cells, which resemble oil cells, common.

Fibers: fairly thick-walled (3.5 μ), but lumina large; average diameter 21 μ; average length 750 μ; pitting not observable.

Pith: center of specimen not preserved, but if a pith existed, it was very small.

Type specimen and slides: No. B-3283 of the Paleobotanical Collection of the University of Cincinnati.

DISCUSSION

Considering pore distribution and size, ray characteristics, perforations in vessels, and intervascular pitting, two families are known which include these characteristics in a manner similar to that exhibited by the specimen. These

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EXPLANATION OF FIGURES IN PLATE II

FIGURES 9–12. *Amyridoxylon ordinatum.* 9—transverse section, × 80; 10—tangential section, × 80; 11—radial section, × 80; 12—tangential section showing intervascular pitting, × 330.

FIGURES 13–15. *Schinoxylon actinoporosum,* × 80. 13—transverse section; 14—radial section; 15—tangential section showing radial gum ducts.

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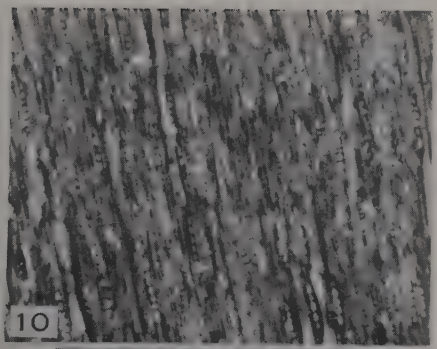
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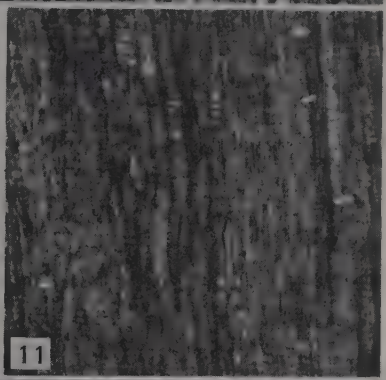
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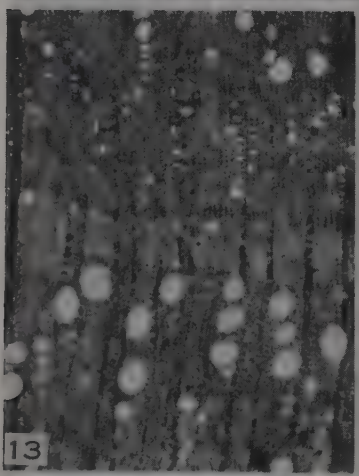
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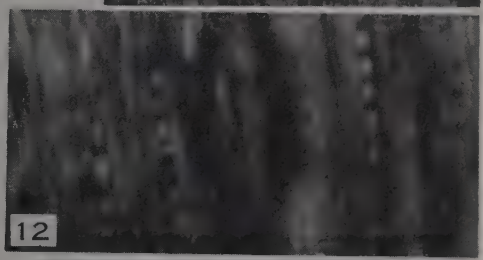
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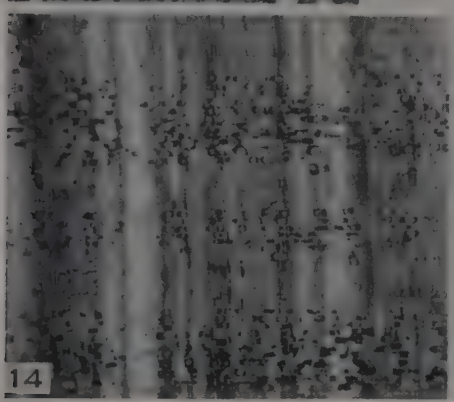
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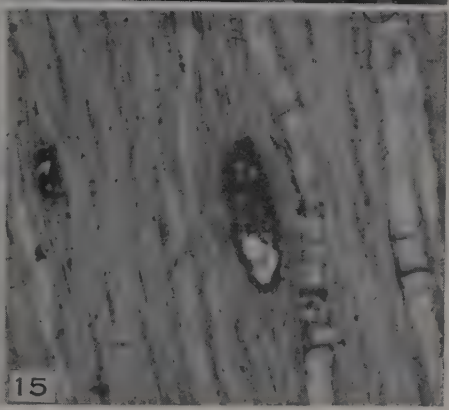
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families are the Magnoliaceae and the Oleaceae, the only significant difference between them being in the arrangement of the wood parenchyma. No parenchyma was observed in the fossil. However, after examination of prepared slides of several species of many genera of both families, it was felt that the specimen should be placed in the Magnoliaceae. Examination of three species of *Talauma* (*T. minor* Urb., *T. sambuensis* Pitt., and *T. gloreinsis* Pitt.) indicates two marked similarities with the specimen. First, the vessel members are unusually long in both the fossil and in the modern species (up to 0.5 mm.); second, all have prominent oil cells in the rays. Furthermore, it was found in *T. gloriensis* that the wood fibers have very thin walls and are indistinguishable from parenchyma as seen in transverse section. This could account for the apparent absence of parenchyma in the specimen. The longitudinal sections of the fossil are not large enough to include an entire growth ring and thus it is quite possible that terminal parenchyma could be completely overlooked.

Not only is the affinity definitely with the Magnoliaceae, but the specimen may be considered as a species of the genus *Talauma* with a fair degree of confidence, although not a modern species. The rather numerous bars in the perforation plates of the vessels suggested the specific name.

As far as it could be ascertained, *Talauma* has not been previously recognized in the fossil record, either as petrified wood or as compressions. The Magnoliaceae, however, is extensively represented as compressions from the Cretaceous to the present throughout the Northern Hemisphere, *Magnolia* L. and *Liriodendron* L. accounting for practically all occurrences. The only authentic fossil wood specimen of the family was described by Hofmann (1952) from the Oligocene of Austria and given a new generic name—*Magnolioxylon*. As compressions the family has many representatives, only a few of which will be mentioned. Lesquereux (1883) described 6 species of *Magnolia* and 8 species of *Liriodendron* from the Cretaceous Dakota group of Kansas, Nebraska, Minnesota, and Colorado. Berry (1916) in his original work on the Wilcox Flora described 2 species of *Magnolia* and in his revision (1930a) adds a new variety to one of his previously described species. Dorf (1942) lists 5 species of *Magnolia* from the Medicine Bow Formation of southern Wyoming and northeastern Colorado. From the Shantung Province of China, Hu and Chaney (1940) describe one species of the same genus of Miocene age.

The present range of *Talauma* is throughout the tropics of the world with the exception of Africa. It does not reach as far north as the United States.

Order: RHOEADALES

Family: CAPPARIDACEAE

Forchhammerioxylon scleroticum, gen. et sp. nov.

(fig. 7, 8)

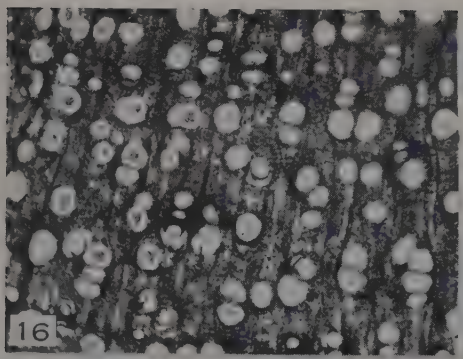
Growth rings: three, clearly marked by tangential bands of conjunctive parenchyma. (Diameter of specimen in which structure was preserved, only 5 mm.)

Vessels: typically diffuse porous; pores all solitary and in no definite arrangement, all more or less of the same size, mostly oval with longer axis radial, averaging 31 by 42 μ; about 75 pores per sq. mm.; vessel member length variable 96 to 184 μ; tyloses apparently absent; perforations not observed distinctly, but apparently simple; end walls inclined from a small angle to about 45 degrees from the horizontal; no pitting observable.

EXPLANATION OF FIGURES IN PLATE III

FIGURES 16–20. Stem of *Fagara monophylloides*. 16—transverse section, × 80; 17—tangential section, × 80; 18—radial section, × 80; 19—radial section showing intervascular pitting, × 330; 20—radial section showing ray to vessel pitting, × 330.

FIGURES 21–24. Root of *Fagara monophylloides*. 21—transverse section, × 80; 22—tangential section, × 80; 23—radial section, × 80; 24—tangential section showing intervascular pitting, × 330.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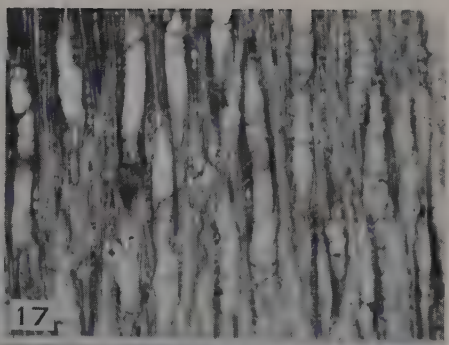
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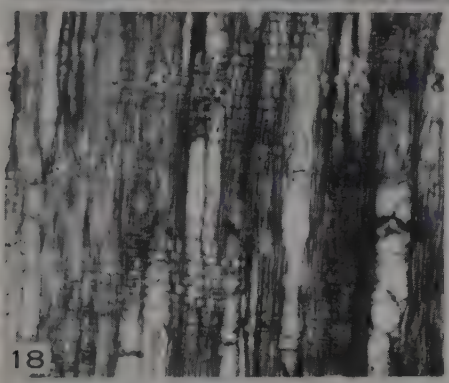
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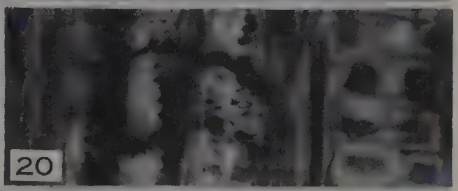
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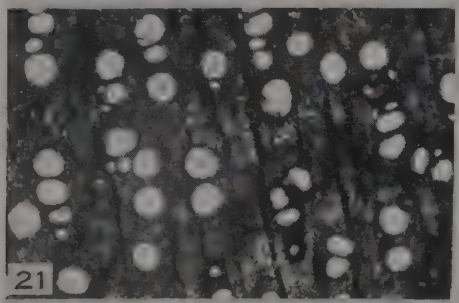
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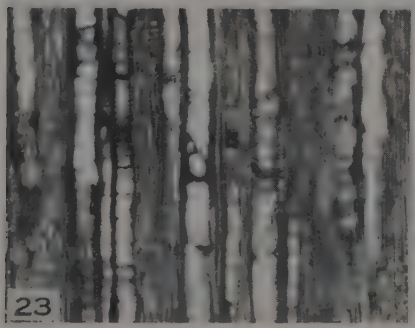
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Wood parenchyma: conjunctive, terminal, averaging 5 or 6 cells in width, fusing with larger rays, thus dividing wood into individual bundles and giving a clover-leaf pattern; cells similar in all respects to those of the rays as seen in transverse section; parenchyma also paratracheal and diffuse, both types in long strands.

Rays: fusiform and considerably twisted as seen in the tangential section; extremely variable in width and height, from uniseriate to 10 cells in width and from 3 to more than 40 cells in height; all cells somewhat elongated vertically as seen on the tangential surface; about 8 rays per mm. as measured on the tangential surface.

Fibers: thick-walled (4 μ) with small lumen, average width 8.8 μ, length not determined, many septate, considerably twisted as seen in tangential surface; pitting not observable; irregular groups of about 12 very thick-walled cells, which apparently are stone cells, are found in the conjunctive tissue immediately on the outside of each phloem area.

Included phloem: concentric type, in irregular patches averaging 100 μ in diameter, near end of each growth ring; usually two areas are found in each bundle formed by the conjunctive tissue and the larger rays; phloem cells completely disintegrated.

Pith: absent (this specimen could possibly be a root).

Type specimen and slides: No. B-3272 of the Paleobotanical Collection of the University of Cincinnati.

DISCUSSION

It must be mentioned that this is a very small specimen (only 5 mm. in diameter) and that only two thin sections could be prepared (transverse and tangential); however, the preservation of cellular detail is good and the description can be fairly complete. The extensive work by Chalk and Chattaway (1937) on modern woods with included phloem was used in the identification of this fossil. It appears that the affinity is definitely with the Capparidaceae, being closely akin to the genus *Forchhammeria* Liebm.

Chalk and Chattaway describe *Forchhammeria* as follows: "Successive bundles of xylem and phloem, repeating the structure of the young stem, separated by tangential bands of conjunctive parenchyma and by large interfascicular rays. *Vessels:* Pores very small, solitary; evenly distributed. Vessel members short; perforations simple; pits to parenchyma small, alternate. *Rays:* Interfascicular predominant, very wide and high; cells variable in size and shape, square to erect, rarely procumbent. Fascicular narrow and low, rare. *Parenchyma:* Conjunctive in tangential bands, separating the xylem and phloem bundles; cells irregular, square or erect, sometimes hexagonal. Metatracheal in short tangential uniseriate lines; cells usually 2 per strand. *Wood fibers:* With moderately thick walls; pits numerous, with small but distinct borders."

The specimen was compared with *F. longifolia* Standl. and it was found that the overall pattern formed by the phloem areas and conjunctive parenchyma is strikingly similar. The minute anatomy, however, showed several important differences as follows: (1) No stone cells are found in the conjunctive parenchyma of *F. longifolia* although they are quite evident in the fossil. Stone cells are found, however, in *Cadaba* Forsk. and *Maerua* Forsk., which are other members of the same family. (2) The Metatracheal parenchyma strands consist of more than two cells in the fossil. (3) Fibers are septate in the fossil but not in the modern wood.

It appears that these differences are too significant to place the specimen in the genus *Forchhammeria* even though there is probably a close affinity. The

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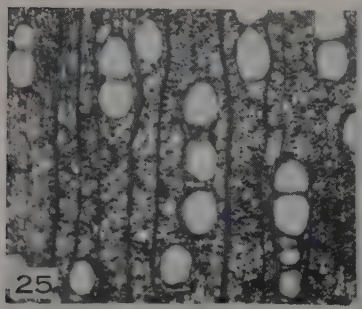
EXPLANATION OF FIGURES IN PLATE IV

FIGURES 25–28. *Fagara biseriata*. 25—transverse section, × 80; 26—tangential section, × 80; 27—tangential section showing intervascular pitting, × 250; 28—radial section, × 80.

FIGURES 29–32. *Suriana inordinata*. 29—tangential section, × 80; 30—radial section, × 80; 31—transverse section showing wood and phloem, × 80; 32—tangential section showing intervascular pitting, × 330.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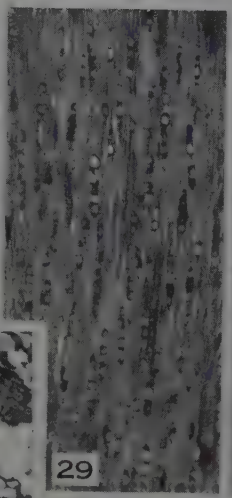
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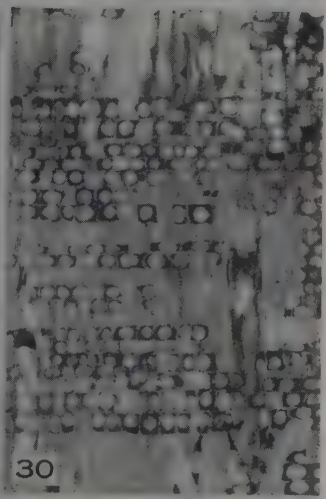
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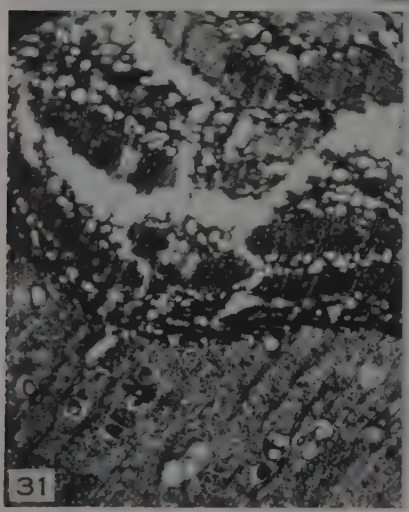
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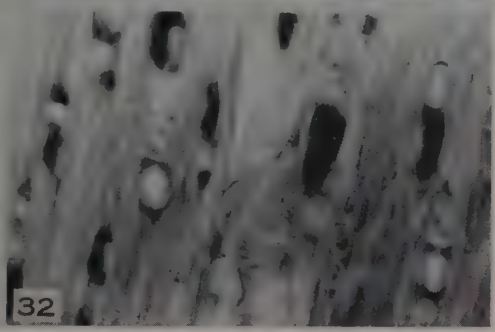
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other genera (*Cadaba* and *Maerua*) mentioned in connection with stone cells are characterized by a marked radial arrangement of the pores. A new genus, *Forchhammerioxylon*, is suggested to show its relationship; its specific name suggests the occurrence of stone cells in the conjunctive parenchyma.

Examinations of the literature failed to reveal references to *Forchhammeria;* in fact, the representation of the Capparidaceae in the fossil record is very scanty. The only record of a wood specimen belonging to the family is *Capparidoxylon geinitzi* Schenk (1883) from the Oligocene of Egypt, which is referred to the genus *Capparis* (Tourn.) L. by the author, but there are no members of this genus which have included phloem. A few references to the family were found in the compression floras of the United States. Berry (1916) describes one species of *Capparis* from the Wilcox and later in his revision (1930a) adds a new variety of the same species. From the Jackson Flora, Berry (1924) describes a seed compression named by him, *Chapparidocarpus*.

Forchhammeria is now confined to the Americas north of the equator, the West Indies and from California to Guatemala and Salvador.

Order: GERANIALES
Family: RUTACEAE

Amyridoxylon ordinatum, gen. et sp. nov.

(fig. 9 to 12)

Growth rings: indistinct; probably three in the type specimen. (Diameter of preserved part of specimen about 25 mm., embedded in thick silicified, colorless matrix.)

Vessels: typically diffuse porous; pores at beginning of growth ring solitary or in multiples of 2 to 5 cells with a tendency toward a tangential arrangement; later pores solitary or more commonly in long radial chains of up to 30 cells; occasionally in tangential multiples of 2 to 10 cells which probably all belong to the same vessel due to shift in direction; pores circular or slightly flattened radially, averaging 28 μ in diameter, numerous, several hundred per sq. mm., possibly over 500; vessel member length averaging 115 μ; tyloses not observed; perforations simple (occasional "elbows" due to tangential shift in direction of members of the same vessel give the appearance in certain parts of the tangential section that the end walls are imperforate); plates inclined at a small angle from the horizontal; intervascular pitting alternate, very fine, about 2 μ in diameter; borders circular; inner apertures included, lenticular, extending nearly to the border, with a tendency to horizontal orientation; vessel to ray pitting not observed; vessel members in horizontal seriation with the rays.

Wood parenchyma: diffuse, very scarce, in short strands of 2 or 3 cells.

Rays: heterogeneous, uniseriate or occasionally biseriate in part, mostly of procumbent cells with occasional interspersed or marginal tiers of square cells; height mostly 7 or 8 cells or 110 μ, which corresponds to one horizontal seriation or tier; fused rays of 2 to 4 tiers of up to 30 cells occasionally found; average width 8 μ; about 20 rays per mm. as measured on the tangential surface.

Fibers: thin-walled (1.6 μ), short, averaging 160 μ in length with a tendency for horizontal seriation with the rays and vessel members; occasionally septate; diameter 7 μ; pitting bordered; borders long oval with longer axis 4 μ; apertures slit-like, included, and oriented vertically.

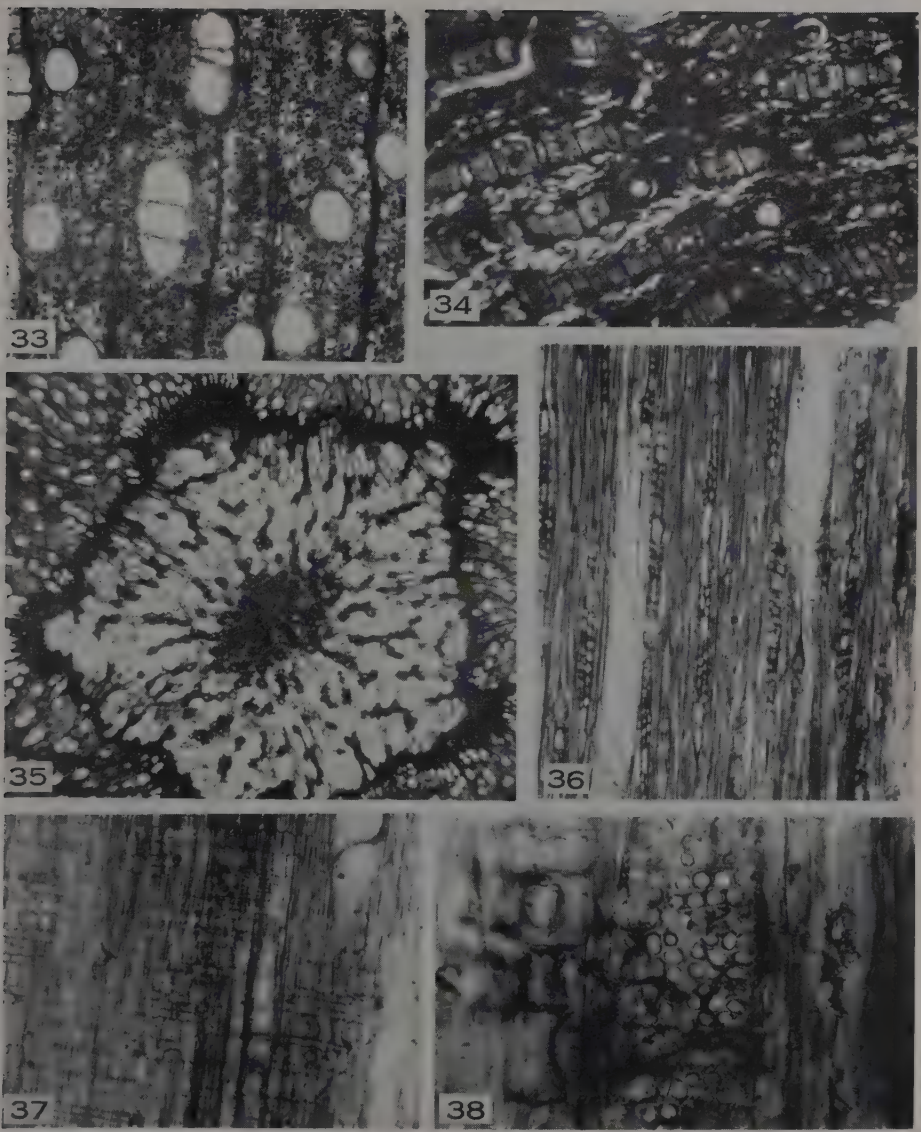
Storied structure: vessel members and rays clearly storied as viewed in tangential section; fibers less definitely so; about 175 tiers per inch.

Pith: small, circular, of large, moderately thick-walled parenchyma.

Type specimen and slides: No. B-3288 of the Paleobotanical Collection of the University of Cincinnati. Other material examined: specimen and slides No. B-3275.

DISCUSSION

On the basis of minute anatomy, it was not difficult to arrive at two families which included all the characteristics of the specimen. These are the Zygophyllaceae and the Rutaceae. The significant differences between these families are as follows:



FIGURES 33–38. *Heveoxylon microporosum.* 33—transverse section, × 80; 34—transverse section of bark showing vertical ducts, × 32; 35—transverse section of pith, × 20; 36—tangential section, × 80; 37—radial section, × 80; 38—radial section showing ray to vessel pitting, × 330.

ZYGOPHYLLACEAE

1. Pores often very irregularly arranged; radially arranged in *Bulnesia*.
2. Fibers never septate.
3. Elements storied in all species.

RUTACEAE

1. Pores mostly in short, sometimes long, radial multiples.
2. Fibers septate in a few species.
3. Elements sometimes storied in *Esenbeckia*.

It will be noted that the Zygophyllaceae are chiefly characterized by exhibiting storied structure in all cases, while a radial arrangement of the pores characterizes the Rutaceae. It was felt that the arrangement of the pores is of more diagnostic value than storied structure, thus the specimen was placed in the Rutaceae. To further substantiate the decision, the presence of septate fibers in the specimen and some species of the Rutaceae, but never in the Zygophyllaceae, offered additional evidence for identification. Also, storied structure has been reported in the genus *Esenbeckia* H., B. et K. Although radially arranged pores are found in *Bulnesia* A. Gray of the Zygophyllaceae, examination of several species of this genus indicated no similarity whatever with the fossil.

Within the Rutaceae, *Amyris* L. appears to be most closely related to the specimen. Five modern species of this genus were compared with the fossil and a marked similarity was found in pore arrangement and rays as seen in tangential section between all the modern woods and the ancient wood. However, storied structure is absent in all these modern species.

With a considerable degree of confidence, this specimen is placed in the Rutaceae, but the presence of storied structure precludes its being placed in the genus *Amyris*. The suggested genus *Amyridoxylon* indicates the other close similarities. The storied structure is indicated in the specific epithet.

No reference was found in the literature of either fossil wood or compressions of *Amyris*, which is similar in many respects to this new genus. Other members of the Rutaceae, however, are well represented and will be discussed in connection with the following species.

Amyris is now confined to the New World: from southern Florida and Texas, southward through Central America to northern South America.

Fagara monophylloides, sp. nov.

(fig. 16 to 20)

Growth rings: obscured by color banding, but at least 4 indistinct rings. (Specimen elliptical, 11 by 16 mm.)

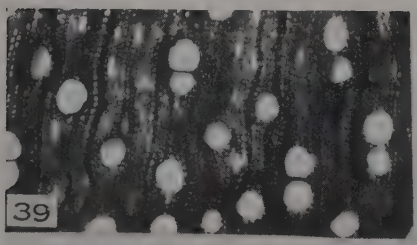
Vessels: typically diffuse porous; pores solitary and in radial chains or multiples of 2 to 7 cells; majority of pores average 42 μ in diameter; occasional pores, usually in chains, average 21 μ in diameter; all gradations between extremes found; pores essentially circular except for radial flattening along line of contact in the multiples, more than 200 per sq. mm.; thick-walled tyloses abundant; vessel member length not determined due to obscuring effect of tyloses; perforations simple; plates inclined about 45 degrees from the horizontal; intervascular pitting alternate, fine, border outline elliptical, longer axis 3.5 μ; inner apertures included, lenticular, and oriented essentially horizontally; vessel to ray pitting fine, simple or very narrowly half-bordered, outline elliptical with longer axis averaging 4 μ, but with considerable variation in size; tendency for horizontal orientation; about 10 pits per cross-field.

Wood parenchyma: paratracheal, fairly abundant, in strands of 3 or 4 cells which are 5 or more times as long as wide; end cells of strands tapering and with tips rounded; pits to vessels

EXPLANATION OF FIGURES IN PLATE VI

FIGURES 39, 40, 42, 43. Stem of *Edenoxylon parviareolatum*, × 80. 39—transverse section; 40—tangential section; 42—radial section; 43—transverse section showing vertical ducts in periderm.

FIGURES 41, 44–46. Root of *Edenoxylon parviareolatum*. 41—transverse section of bark and wood, × 32; 44—tangential section, × 80; 45—tangential section showing intervascular pitting, × 330; 46—radial section, × 80.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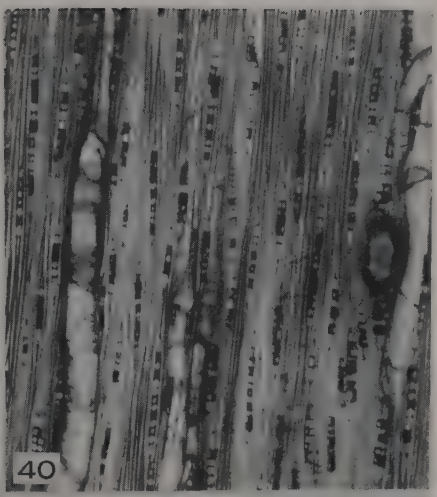
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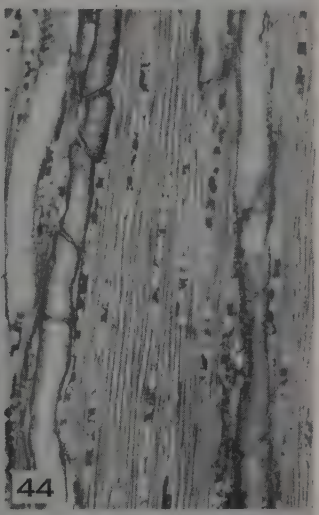
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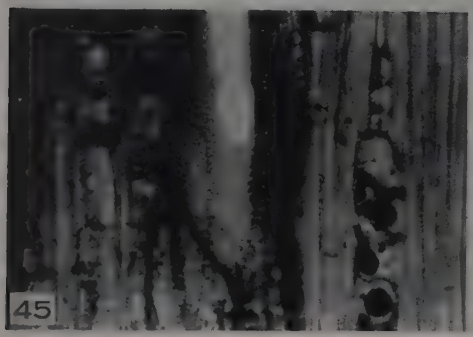
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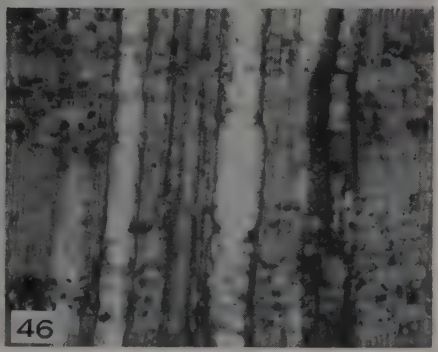
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apparently half-bordered; border outline long elliptical with longer axis varying from 4 to 6.5 μ; apertures on vessel side of pit-pairs lenticular to slit-like, included, and horizontally oriented; parenchyma also diffuse in long vertical multiseriate strands of large, irregularly shaped cells, all with dark content, very suggestive of pith flecks.

Rays: heterogeneous, uniseriate or very rarely biseriate in part; marginal cells usually upright, occasional tier or tiers of upright or square cells in interior of rays; the rest of the cells procumbent; height of rays 5 to 22 cells, averaging 10, maximum 840 μ; maximum width 13 μ; about 18 rays per mm. as measured on the tangential surface.

Fibers: rather thick-walled (3.2 μ), lumen small; diameter 8 μ; length not determined; pitting not observable.

Pith: rather large (3 mm. in diameter), more or less circular, of isodiametric parenchyma cells without intercellular spaces.

Type specimen and slides: No. B-3279 of the Paleobotanical Collection of the University of Cincinnati.

DISCUSSION

This specimen definitely belongs in the Rutaceae. Examination of the fossil record of the members of this family suggested the genus *Fagara* L. Comparing the specimen with a prepared slide of *Fagara monophylla* Lam., the similarity was astounding in every detail. Even the gross appearance of the specimen is strikingly similar to a small branch of this species.

The specific epithet of the specimen is suggestive of the extremely close relationship to the modern species of *Fagara* mentioned above. It was deemed advisable not to use this species name since it is frequently impossible to differentiate species of a given genus by wood anatomy alone.

Fagara is well represented in the fossil record in the United States, but apparently it is confined entirely to the Eocene. The geographic range of the compressions is widely scattered, due, no doubt, to the limits of the genus itself. Linnaeus and Engler recognize *Fagara* as a genus distinct from *Zanthoxylum*, while many other authors group both genera under *Zanthoxylum*. The latter genus also is widely known in the fossil condition. Those identified as belonging to *Fagara* L. have been collected from Florida, Kentucky, Tennessee, Mississippi, Texas, Colorado, Wyoming, and California. It has also been found in the West Indies and Mexico. Berry (1916) describes 3 species from the Wilcox Flora, all of which are substantiated in his revision (1930a). The same author (1924) describes 2 species from the Claiborne Flora and 4 from the Jackson Flora. Later, one species was identified by Berry (1930b) from the Wind River Basin of Wyoming which is of Green River age. It has not been described from the Green River Flora itself. One species has been identified by Berry (1938) from Argentina.

The fossil wood of *Fagara* has not previously been reported, but there are several known members of the family Rutaceae. Several species of *Evodioxylon* Chiarugi have been described; one by Hofmann (1952) from the upper Oligocene of Austria, and another by Boureau (1950) from the Oligocene of Libya.

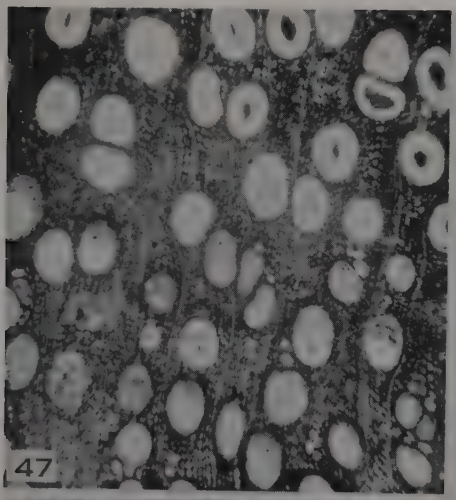
The living members of the genus are pantropical in distribution. In the United States, it is only found in southern Florida.

ROOT of **Fagara monophylloides,** sp. nov.
(fig. 21 to 24)

Growth rings: obscured by color banding, but at least 7 more or less distinct rings present; the last two, clearly defined. (Specimen considerably flattened, 43 by 22 mm.)

EXPLANATION OF FIGURES IN PLATE VII

FIGURES 47–52. *Aspidospermoxylon uniseriatum.* 47—transverse section, × 80; 48—tangential section, × 80; 49—radial section, × 80; 50—tangential section showing radial gum duct, × 80; 51—transverse section of cortex showing vertical ducts, × 80; 52—radial section showing intervascular pitting, × 330.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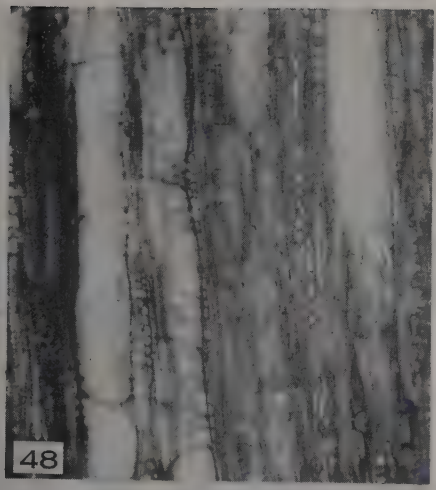
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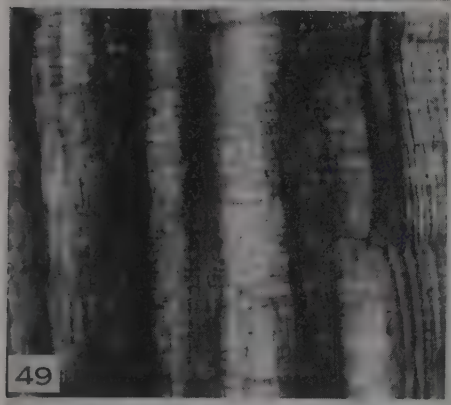
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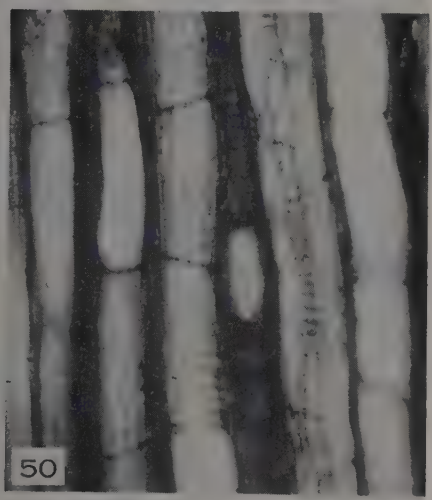
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52

Vessels: typically diffuse porous; pores solitary and in radial chains or multiples of 2 to 9, averaging 7 cells; chains of large and small cells intermixed; diameter of pores variable, 56 μ down to 21 μ, with majority at either extreme, but with all gradations; larger pores essentially circular, smaller pores, when in multiples, radially flattened; thick-walled tyloses abundant in all vessels; about 150 pores per sp. mm., larger pores slightly more numerous at beginning of growth ring; vessel member length averaging 150 μ; intervascular pitting alternate, fine, border outline slightly elliptical with longer axis 4 μ; inner apertures included, lenticular, and oriented essentially horizontally; vessel to ray pitting fine, simple or very narrowly half-bordered; outline elliptical with considerable variation in size, average longer axis 3.2 μ; no orientation; 8 or 9 pit-pairs per cross-field.

Wood parenchyma: paratracheal, fairly abundant, cells greatly elongated vertically, in strands of 5 to 7 cells, end cells of strands tapering with tips rounded; pits to vessels apparently half-bordered; what appears to be border outline lenticular with longest axis varying from 4 to 8 μ; inner apertures on vessel side included, lenticular, and oriented horizontally.

Rays: heterogeneous, uniseriate, marginal cells usually upright; occasional tier or tiers of square or upright cells in interior of rays; rest of cells procumbent; height of rays 5 to 14, averaging 8 cells, maximum 300 μ; maximum width 14.5 μ; about 12 rays per mm. as measured on the tangential surface.

Fibers: fairly thin-walled (1.5 μ), diameter 8 μ; pitting not observable.

Pith: absent, although center is preserved.

Specimen and slides: No. B-2864 of the Paleobotanical Collection of the University of Cincinnati.

DISCUSSION

In spite of minor differences in size of various elements, there appears to be no doubt that this specimen belongs with the stem described above. The thin walls in the wood fibers of the root, as compared with the stem, is to be expected on the basis of the comparative anatomy of these two organs. It will be noted that the pith is quite large in the stem, while in this specimen, it is entirely absent. Unfortunately, the primary xylem was not preserved, thus it is impossible to determine the position of the protoxylem.

Fagara biseriata, sp. nov.

(fig. 25–28)

Growth rings: fairly distinct, 5 present in specimen. (Diameter of specimen 36 mm.)

Vessels: diffuse porous with slight tendency to diminution in size of pores during growth period; pores solitary and in radial chains of 2 to 8 or 9 cells; diameter of pores extremely variable, 77 μ in early wood, 50 μ in late wood, many small pores only 8 μ; majority at the extremes but all gradations are found; pores circular or slightly elongated radially, walls fairly thick (3.5 μ), 60 to 100 per sq. mm.; thin-walled tyloses abundant in the larger vessels; members of larger vessels; members of larger vessels averaging 260 μ in length, smaller vessels up to 370 μ with long tails extending considerable distance beyond perforation; perforations simple; plates nearly horizontal with a wide rim in the largest vessels and a gradual transition to very steeply inclined in the smallest vessels; intervascular pitting alternate, very fine, crowded but not touching; pit borders of larger vessels elliptical, 3.6 by 2.4 μ, of the smaller circular, 3.2 μ in diameter; apertures slit-like, included, and nearly as long as the border; orientation horizontal in the larger vessels, nearly vertical in the smallest, all gradations in intermediate-sized vessels; vessel to ray pitting not observed.

Wood parenchyma: paratracheal, very sparse, occasional strands of 4 or 5 cells adjoining a few of the vessels.

Rays: heterogeneous, mostly biseriate with uniseriate margins of 1 to 3 cells and occasional single cells in interior of rays; rarely triseriate in part; marginals square or slightly upright, interior cells procumbent; occasional low uniseriate rays; all cells fairly thick-walled (2 μ); height 6 to 33 cells, averaging 20, maximum 560 μ; maximum width 27 μ; about 16 rays per mm. as measured on the tangential surface.

Fibers: moderately thick-walled (3 μ), 8 μ in diameter and 450 μ in length; pitting not observed.

Pith: small, circular, of large parenchyma cells all with dark content.

Primary xylem: narrow band preserved; protoxylem not distinguishable.

Type specimen end slides: No. B–2819 of the Paleobotanical Collection of the University of Cincinnati.

DISCUSSION

The microscopic examination of a transverse section of this specimen showed a decided similarity to the species of *Fagara* previously described. The pore arrangement is identical and both show a large variation in size of the vessels. This specimen, it will be noted, exhibits two types of intervascular pitting while *Fagara monophylloides* shows only one type; however, pitting was observable in only the largest vessels of the previously described species and thus unknown in the smaller vessels. The only significant difference is in the width of the rays—almost entirely uniseriate in *F. monophylloides*, mostly biseriate in this specimen. Slight differences in the various elements are to be expected, since this fossil is larger than the former species.

The biseriate character of the rays suggested the specific name.

Family: SIMARUBACEAE

Suriana inordinata, sp. nov.

(fig. 29–32)

Growth rings: very indistinct or possibly absent. (Diameter of specimen 20 mm.)

Vessels: typically diffuse porous; pores solitary and in chains or radial multiples of 2 to 11 or 12 cells, very rarely in small clusters, all more or less of same size, averaging 35 μ in diameter; solitary pores slightly elongated radially, those in chains radially flattened along line of contact; about 140 pores per sq. mm.; average length of vessel members 175 μ; tyloses apparently absent; perforations simple with a wide rim; plates inclined about 45 degrees from the horizontal; intervascular pitting alternate, rather crowded, very fine, about 3 μ in diameter; border outline decidely angular; inner apertures elliptical, included and oriented more or less horizontally; vessel to ray pitting very fine, half-bordered, about 3 μ in diameter, outline circular or slightly elongated horizontally; about 12 pits per cross-field.

Wood parenchyma: very sparingly paratracheal, in short strands.

Rays: heterogeneous, entirely uniseriate; most of cells square, occasional tiers of slightly upright or slightly procumbent cells; cell walls thickened in corners as seen in radial section, making lumen appear circular; height 3 to 13 cells, averaging 6 or 7 cells, 70 to 300 μ; maximum width 15 μ; about 20 rays per mm. as measured on the tangential surface.

Fibers: fairly thin-walled (2 μ), average diameter 7 μ, length approximately 230 μ; pitting not observed.

Pith: relatively small, roughly circular, of rounded, large (35 μ in diameter) parenchyma cells which are more or less disconnected.

Primary xylem: a few cells remaining next to pith; protoxylem not distinguishable.

Vascular cambium: cambial zone only one cell in width.

Phloem: about one half of very thick-walled fibers and one half of sieve tubes with a tendency for the two tissues to alternate in concentric, but discontinuous bands.

Type specimen and slides: No. B-2868 of the Paleobotanical Collection of the University of Cincinnati. Other material examined: specimen and slides No. B-2809.

DISCUSSION

Record and Hess (1943) place *Suriana* in a separate family, the Surianaceae; Metcalfe and Chalk (1950), however, feel that on the basis of wood structure, there is no need to separate it from the Simarubaceae. The latter position has been accepted in this case.

Wood of *Suriana maritima* L. was compared with the fossil. The radial sections were remarkably similar, i.e., both showed a preponderance of square cells in the rays with walls thickened in the corners. Other sections showed a few differ-

ences as follows: (1) Ripple marks are indistinctly defined in the modern wood, but definitely absent in the specimen. (2) Wood fiber walls are thinner in the specimen than they are in the modern wood.

Ripple marks are not of much diagnostic value, especially when all other characteristics fit very closely. Perhaps they are the result of environment and thus would not be present consistently throughout even such a small group as a species. Fiber wall thickness can vary considerably within a genus.

The specific epithet suggests the lack of storied structure which is present in the only modern species of *Suriana*.

As far as it could be ascertained, *Suriana* has not previously been reported from the fossil record either as wood or as a compression. The Simarubaceae, however, have a few representatives, the most important of which is *Ailanthus* Desf. Compressions of this genus have been found from the Eocene and Miocene of western North America and from the Oligocene and Miocene of Europe. Hu and Chaney (1940) describe one species from the Miocene of China. Berry (1916) describes a species of *Simaruba* DC. from the Wilcox Flora and later in his revision (1930a) sets up a new genus *Simarubites* under which he describes one species.

Platen (1908) described two species of fossil wood belonging to this family from the Tertiary of Nevada County, California, both of which he assigned to a new genus, *Simarubinium*. In both cases the diagnosis is brief and illustrations are lacking.

Suriana is pantropical in distribution, usually occurring along sea coasts. In the United States, one species is found in southern Florida.

Family: EUPHORBIACEAE

Heveoxylon microporosum, gen. et sp. nov.

(fig. 33 to 38)

Growth rings: very indistinct or possibly absent. (Diameter of specimen 31 mm.)

Vessels: typically diffuse porous; pores solitary and in radial multiples of 2 to 9 cells, rarely in small clusters, extremely variable in size from 100 μ down to 20 μ in diameter (smaller pores are probably elongated tips of vessel members); solitary pores circular, those in multiples flattened along line of contact, 30 to nearly 100 per sq. mm. with considerable variation in different parts of the section; moderately thick-walled tyloses abundant; vessel member length variable 265 to 575 μ; perforations simple; plates steeply inclined from the horizontal; intervascular pitting alternate, fine, detail not preserved; vessel to ray pitting fine, simple or very narrowly half-bordered; outline circular to occasionally elliptical; circular pits average 6 μ in diameter, elliptical pits 5.6 by 12 μ with longer axis horizontal; 6 to 10 pits per cross-field, appearing sieve-like.

Wood parenchyma: sparingly paratracheal, in long vertical strands, cells considerably elongated vertically; also metatracheal, in irregular multiseriate bands.

Rays: strikingly heterogeneous; all rays both uniseriate and biseriate, with alternation from one-celled to two-celled condition as many as 9 times in a given ray; marginal cells very long-pointed as seen in tangential section; uniseriate parts of rays and margins of rays of large upright or square cells, biseriate parts of small procumbent cells which are greatly elongated radially and greatly flattened vertically; many of larger cells rounded as seen in radial section; height of rays 10 to over 40 cells, averaging 15 to 20, some over 1 mm. high, mostly less; maximum width 27 μ. About 10 rays per mm. as measured on the tangential surface.

Fibers: fairly thick-walled (3.5 to 4.0 μ); average diameter 16 μ; length not determined; pitting not observed.

Pith: relatively large (3 mm. in diameter), pentagonal, center of round to hexagonal cells all with dark content; rest of pith mostly of elongated cells as seen in transverse section; no intercellular spaces.

Phloem: in numerous concentric, but interrupted bands, alternating with periderm; sieve tubes greatly elongated vertically and considerably twisted; sieve plates not observed; parenchyma in diffuse strands, very sparse; phloem rays less heterogeneous than xylem rays.

Periderm: in numerous concentric, interrupted bands, alternating with phloem; cellular detail not preserved; numerous vertical ducts, circular to somewhat tangentially elongated, averaging 90 μ in diameter.

Type specimen and slides: No. B-2791 of the Paleobotanical Collection of the University of Cincinnati.

DISCUSSION

Modern species of *Heava* Aubl. all show one prominent feature in common with the fossil—extreme heterogeneity of the rays with a marked alternation from a uniseriate to a biseriate condition as viewed on the tangential surface. Furthermore, one species—*H. microphylla* Ule—not only shows this type of ray but has all other characteristics in common with the fossil except the size of the pores. The pores are larger in the modern wood, but this is to be expected since the modern slide is from mature wood, while the slide of the fossil was made from a very young stem.

On the basis of Record's (1938) description of the wood of *Hevea*, it is difficult to justify the inclusion of this specimen in this genus because of the following significant differences:

GENERIC DESCRIPTION	FOSSIL
1. Pores mostly large.	1. Pores medium-sized (less than 100 μ).
2. Rays less than 30 cells high.	2. Rays sometimes over 40 cells high.
3. Intervascular pitting rather large.	3. Intervascular pitting fine.
4. Wood parenchyma abundant, reticulate and in irregular narrow bands.	4. Wood parenchyma sparingly paratracheal, also metatracheal in irregular bands.
5. Wood fibers with thin walls.	5. Wood fibers with fairly thick walls.

In spite of these differences, the fossil is remarkably similar to *H. microphylla*. Perhaps, this species was not examined when the generic description was prepared or it should be re-examined for the possible inclusion in another genus. Nevertheless, it is with considerable confidence that this specimen is placed in the Euphorbiaceae and the subfamily Crotonoideae on the basis of ray characteristics alone. Unfortunately, it was impossible to compare other tissues, such as pith, phloem, and periderm.

The generic name suggests the affinity to the one species of *Hevea—H. microphylla*—and the specific name refers to the small pores of the specimen in comparison with the genus in general.

No fossil reference to the genus *Hevea* was found in the literature from either North or South America; in fact, the record of the family Euphorbiaceae is very scanty. Most of the fossil occurrences in North America are from the upper Cretaceous and Eocene with the family practically unreported, particularly in the western part of the continent, after the Eocene. No member of the family has previously been reported from the Green River Flora. Berry (1916), however, from the Wilcox Flora, describes two species of *Drypetes* Vahl., two species of *Crotonophyllum* Velen., and one species of *Euphorbiophyllum* Ettingshausen. Later (1930) he adds one species of *Manihot* Adamson.

Felix (1887) describes from the Tertiary of Columbia the only fossil wood that could be found that is directly referable to the Euphorbiaceae. The new generic and specific name given by him is *Euphorbioxylon speciosum*.

Considering the similarity in the leaf form and structure of *Hevea* and *Ficus* L., and the many reports of the latter genus in the compression floras, it appears quite possible that at least some of the fossil plants referred to *Ficus* might belong to *Hevea*.

Hevea is now confined to northern South America, ranging from the Amazon Basin northward to Venezuela and the Guianas.

Order: SAPINDALES
Family: ANACARDIACEAE

Schinoxylon actinoporosum, gen. et sp. nov.
(fig. 13, 14, 15)

Growth rings: inner rings indistinct; outer rings fairly clearly marked. (Diameter of specimen 28 mm.)

Vessels: diffuse porous, but with a tendency for the larger pores to be more numerous at beginning of growth ring, at least in the later rings; vessels of two kinds: (a) vessels of all sizes with members averaging about 100 μ in length and with essentially horizontal end walls (they frequently show a tangential shift in the vertical alignment of the vessel members, in which case the laterally connected members have long and somewhat rounded tails extending beyond the perforations); (b) very small tracheid-like vessels with members averaging over 300 μ in length and with very long steeply inclined end walls (at least three simple perforations were observed in the radial section, indicating that these cells are vessels and not tracheids); larger pores mostly solitary, sometimes in radial multiples of 2 to 4 cells; medium sized and smaller pores occasionally solitary, but mostly in radial chains or multiples of up to 25 cells; rarely, clusters are found of all sizes; pores quite variable in size from 70 μ down to 15 μ, essentially circular except for flattenng along line of contact when in multiples, about 100 per sq. mm.; moderately thick-walled tyloses abundant in the larger vessels; fine, but distinct, spiral thickenings on the vessels of type (a); perforations simple; intervascular pitting of vessels of type (a) alternate, fine, border outline circular or slightly oval, diameter 4 μ, inner apertures slit-like, included and without definite orientation; of type (b) alternate, fine, border outline circular, diameter 5 μ, inner aperture slit-like, included, and oriented half way between vertical and horizontal, outer aperture very small, circular; vessel to ray pitting fine, simple, circular to elliptical, 4 to 5 μ in longest dimensions; about 8 pits per cross-field.

Wood parenchyma: apparently absent.

Rays: heterogeneous; uniseriate entirely or uniseriate and biseriate in part; marginal cells upright in radial section and long pointed in tangential section; interspersed tiers of upright or square cells in interior of only the high rays; other cells procumbent; height of rays 7 to 20 cells, averaging 13, 100 to 330 μ; maximum width 20 μ; about 15 rays per mm. as measured on the tangential surface.

Fibers: rather thin-walled; average diameter 8 μ; length not determined; pitting not observed.

Gum ducts: radial, numerous, elongated vertically, variable in size from 30 by 75 μ to 90 by 280 μ; rays containing ducts considerably enlarged.

Pith: small, circular or somewhat oval, of nearly round parenchyma cells without intercellular spaces.

Bark: cellular detail lacking, but it (probably periderm) contains numerous oval, tangentially elongated vertical ducts, averaging about 40 by 80 μ.

Type specimen and slides: No. B-2818 of the Paleobotanical Collection of the University of Cincinnati. Other material examined: specimen and slides No. B-2822.

DISCUSSION

After this and the following specimen were tentatively assigned to the Anacaridaceae, the material was sent to Dr. Jeannette Kryn of the Forest Products Laboratory for confirmation. In a personal communication, Dr. Kryn lists the following as the most characteristic features of the family: "(1) Large to moderately large, solitary pores or multiples of two or three. (2) Large intervascular pit pairs. (3) Very large, horizontally elongated or gash-like, half-bordered vessel to ray pit pairs."

It is the feeling of Dr. Kryn and the author that size of the elements can be discounted on the grounds that the specimens are very young stems in comparison with the mature wood of the modern material. The presence of horizontally elongated or gash-like ray to vessel pit pairs in the fossils supported

the belief that the material was correctly placed in the Anacardiaceae, especially since radial gum ducts are so prominent in the rays.

It was suggested by Dr. Kryn that this specimen is similar in all respects to *Schinus* L. except for the arrangement of the pores as seen in transverse section; in *Schinus* they form an ulmiform pattern, while here they are definitely radially arranged. Since the specimen differs from *Schinus* in only this one characteristic and it surely belongs to the Anacardiaceae, although not exactly matching a modern genus, its affinity is suggested by the generic name. The specific epithet indicates the radial arrangement of the pores in contrast to the modern species of *Schinus*.

Schinus has not been reported in the fossil condition from North America, although Berry (1938) has reported one species from the Tertiary of Argentina. The Anacardiaceae, however, is well represented as compressions from the upper Cretaceous to the present throughout the world. The most abundant representatives belong to the genera *Rhus* L., *Pistacia* L., and the form genus *Anacardites* Saporta.

Two genera of anacardiaceous fossil woods have been previously described:

1. *Anacardioxylon* Felix (1882).
   - *A. spondiaeformis* Felix (1882) from the Tertiary of Antigua.
   - *A. uniradiatum* Felix (1894) from the Eocene of the Caucasus.
   - *A. magniporosum* Platen (1908) from the Tertiary of California.
2. *Rhoidium* Unger (1850).
   - *R. juglandinum* Unger (1850) from the Tertiary of Hungary.
   - *R. philippinense* Crié (1889) from the Tertiary of the Philippines.
   - *R. ungeri* Mercklin (1855) from the Cretaceous of Russia.

Although one species of *Schinus* is cultivated in southern California, the genus is now native to South America, the Hawaiian Islands, and St. Helena.

Edenoxylon parviareolatum, gen, et sp. nov.

(fig. 39, 40, 42, 43)

Growth rings: apparently absent, although 3 concentric color rings are present. (Diameter of specimen 37 mm.)

Vessels: typically diffuse porous; pores solitary and in radial chains of 2 or 3 cells, occasionally in chains of up to 9 cells made up of small pores, essentially circular, majority averaging 50 μ in diameter, a few in the longer chains 20 to 35 μ in diameter, about 100 per sq. mm.; fairly thick-walled tyloses abundant; vessel members variable in length from 100 to 300 μ; perforations simple; plates nearly horizontal to an inclination of about 45 degrees from the horizontal; intervascular pitting alternate, fine, border outline lenticular, 4 μ in longest axis; inner apertures included, lenticular to slit-like, and extending almost to border outline; orientation horizontal; vessel to ray pitting fine to medium, simple, varying from round, about 4 μ in diameter to long oval with longer axis about 8 μ; occasionally pits are close enough to each other to give a reticulate pattern; no orientation of any pit-pairs.

Wood parenchyma: apparently absent.

Rays: heterogeneous; mostly uniseriate, rarely biseriate in part; in most cases marginal tier of cells are upright with occasional interspersed tiers of square or upright cells in interior of larger rays; rest of cells procumbent; height of rays 2 or 3 up to 20 cells (70 to 450 μ), averaging about 13 cells; maximum width 13 μ; about 20 rays per mm. as measured on the tangential surface.

Fibers: fairly thin-walled (2.4 μ); average diameter 10 μ; length not determined but in excess of 0.5 mm. with long tapering ends; many septate with very thin nearly horizontal septa; pitting not observed.

Gum ducts: radial gum ducts fairly numerous within fusiform rays which become bi- or triseriate at top and bottom of duct with a single row of cells laterally; larger ducts 140 by 70 μ, smaller 63 by 28 μ; epithelial cells not preserved.

Pith: relatively large, somewhat distorted by compression, but probably circular, of large,

essentially hexagonal parenchyma, without intercellular spaces; more than half of cells filled with dark substance.

Phloem: consists of 4 or 5 narrow concentric bands separated by periderm (?); "living phloem" (closest to wood) very narrow; phloem bands themselves banded by concentric rings of dark cells, which are probably parenchyma cells, since they have the same appearance as the ray parenchyma; companion cells and fibers not observed.

Periderm: existence not definitely ascertained, but it possibly appears as narrow concentric rings alternating with phloem tissue (rhytidome structure?); region contains numerous circular or slightly oval vertical ducts averaging 12 μ in diameter; cellular detail too poorly preserved for further description.

Type specimen and slides: No. B-3280 of the Paleobotanical Collection of the University of Cincinnati.

DISCUSSION

This specimen of a young stem and a root of the same thing were also examined by Dr. Kryn and it was her conviction that they belonged to the Anacardiaceae, in spite of the fact that they could not be placed in any modern genus. It will be noted that two characteristic features of the family are present: (1) horizontally elongated or gash-like vessel to ray pitting, and (2) radial gum ducts in the rays. It is, without too much confidence, that this specimen is placed in the Anacardiaceae. A new genus name is proposed indicating the locality of occurrence—Eden Valley. The specific name is suggestive of the small intervascular pits which are not characteristic of the family as a whole.

ROOT of **Edenoxylon parviareolatum,** gen. et sp. nov.

(fig. 41, 44, 45, 46)

Growth rings: very indistinct; possibly three in specimen. (Diameter of specimen 17 mm.)

Vessels: typically diffuse porous; pores solitary and in radial chains or multiples of 2 to 6 cells, occasionally in chains of up to 10 cells made up of very small pores, essentially circular except for flattening along line of contact, majority averaging about 65 μ in diameter, a few in the longer chains about 20 μ in diameter, 75 to 100 per sq. mm.; thick-walled tyloses in a few vessels; vessel members variable in length from 100 to 335 μ; perforations simple; plates nearly horizontal to an inclination of about 45 degrees from the horizontal; intervascular pitting alternate, fine, border outline elliptical, 4 μ along longer axis; inner apertures included, lenticular to slit-like and extending almost to border; orientation horizontal; vessel to ray pitting not well preserved, but apparently similar to that of the stem; i.e., pits simple or possibly with a very narrow border on the vessel side of the pit-pairs.

Wood parenchyma: sparingly paratracheal, in long strands of cells which are 2 or 3 times as long as wide (in tangential section) and rather large, width about 18 μ; ends of strands somewhat pointed; pitting to vessels rather coarse and apparently half-bordered; outline greatly elongated horizontally and frequently nearly as long as the width of the parenchyma cell in tangential section.

Rays: heterogeneous; mostly uniseriate, rarely biseriate in part; in most cases marginal tiers of cells are upright with frequent interspersed tiers of square or upright cells in interior of larger rays; rest of cells procumbent, but not greatly elongated radially; height of rays 2 up to 15 cells (100 to 630 μ), averaging 10 cells; maximum width 16 μ; about 16 rays per mm. as measured on the tangential surface.

Fibers: thin-walled (1.5 μ); average diameter 10 μ; length not determined; many septate with thin, nearly horizontal septa; pitting not observed.

Gum ducts: radial gum ducts very infrequent (only one observed) within fusiform ray, oval vertically elongated, 65 by 32 μ; epithelial cells not preserved.

Pith: absent.

Phloem: phloem tissue quite broad and consisting almost entirely of vertically elongated sieve tubes which vary considerably in length; sieve plates not observed; ray cells mostly square

or upright as viewed in radial section; region contains numerous, oval, tangentially elongated, vertical ducts arranged in 5 concentric bands with a tendency for the size to increase centrifically, the smaller averaging 70 by 120 μ, the larger roughly 100 by 280 μ.

Vascular cambium: region broken in specimen, but the zone is at least 4 cells in width; cells as seen in longitudinal sections 3 to 5 times as long as wide and with horizontal end walls.

Specimen and slides: No. B-3278 of the Paleobotanical Collection of the University of Cincinnati.

DISCUSSION

Under low magnification, there appears to be no difference between this specimen and the stem previously described except for the absence of a pith in this case. Under higher magnification, minor differences were noted as follows: (1) almost all elements are slightly smaller in the stem, and (2) wood parenchyma is absent in the stem while it is sparingly paratracheal in the root. These differences are to be expected on the basis of the comparative anatomy of these two organs. After all considerations, it is felt that these two specimens definitely belong to the same species of plant.

Order: CONTORTAE
Family: APOCYNACEAE

Aspidospermoxylon uniseriatum, gen. et sp. nov.
(fig. 47 to 52)

Growth rings: absent. (Specimen very irregular in outline, about 26 mm. in diameter.)

Vessels: typically diffuse porous; pores mostly solitary, occasionally in multiples of two, no definite arrangement, oval with longer axis radial, somewhat variable in size but mostly 84 to 140 μ in diameter, number variable in different parts of specimen from 40 to 60 per sq. mm.; thin-walled tyloses in some vessels; vessel members 240 to 370 μ in length; perforations simple; plates transverse or slightly oblique; intervascular pitting alternate, very small (4 μ); apertures included, indistinct, but apparently slit-like and with horizontal orientation; ray to vessel pitting not observed; vessels as seen in longitudinal sections occupy more than 50 per cent of field.

Wood parenchyma: fairly abundant, paratracheal, in long strands of 9 or more cells. (Wound parenchyma also present.:

Rays: heterogeneous; mostly uniseriate, occasionally biseriate in part; cells in interior of rays mostly procumbent, but with occasional tiers of square or slightly upright cells; marginals square or slightly upright; cells fairly thick-walled (2 μ), many of the larger with a dark content; height variable 4 to 26 cells or 35 to 430 μ; width averaging 17 μ; about 12 rays per mm. as measured on the tangential surface.

Fibers: fairly thin-walled (2 μ); average diameter 18 μ; average length 300 μ; pits bordered, very small, 4 μ in diameter.

Gum ducts: radial, widely scattered, within fusiform rays, oval with longer axis vertical, about 150 by 60 μ in tangential section.

Pith: if present, not preserved.

Phloem: of sieve tubes and concentric bands of fibers; occasional oval, tangentially elongated, vertical ducts 55 by 70 μ.

Cortex: of parenchyma cells with scattered strands of fibers; oval, vertical, and tangentially elongated ducts 70 by 90 μ.

Type specimen and slides: No. B-2866 of the Paleobotanical Collection of the University of Cincinnati.

DISCUSSION

Poor preservation of this specimen made identification difficult; however, the presence of radial gum ducts, uniseriate rays, and very fine intervascular pitting eliminated many families, reducing the possibilities to seven. Many modern representatives of these families were examined and it was found that

the Apocynaceae gave the best "fit" in all characteristics. An outstanding feature of this specimen is the large area covered by the vessels as seen in both longitudinal sections. Only the genus *Aspidosperma* Mart. et Zucc. showed this character to any degree, being particularly evident in *A. cruentum* Woodson.

It is felt that the specimen belongs to the Apocynaceae, but does not fit any modern genus sufficiently close to be included in any of them. The similarity to *Aspidosperma* is suggested in the genus name and the species name indicates the uniseriate condition of the rays of the fossil which is not reported for in any examples of modern species.

Descriptions of the fossil woods of the Apocynaceae are lacking. There are, however, a few members of the family which have been reported as compressions from the New World:

(1) *Aspidosperma*, one species from Puerto Rico (Hollick 1924).
(2) *Apocynophyllum* Unger, 9 species and one variety from the Wilcox Flora (Berry 1916, 1930a), 2 species each from the Claiborne and Jackson Floras (Berry 1924), and one species from the Green River Flora (Brown 1934).
(3) *Echitonium* Unger, one species from the Wilcox Flora (Berry 1916).
(4) *Apocynospermum* Brown, one species from the Green River Flora (Brown 1929).
(5) *Allamanda* L., *Plumiera* L., *Echites* L., and *Landolphia* Pal. Beauv., one species each from the Tertiary of Argentina (Berry 1938).

Aspidosperma is now native to tropical America with the highest concentration of species in Brazil. Its range does not extend into the United States.

SUMMARY

This study is concerned with the description and identification of a number of silicified dicotyledonous woods from the Green River Formation (upper Lower Eocene) of the Eden Valley in southwestern Wyoming. Eleven specimens are described and identified. All the species and six of the genera are new. The following is a systematic list of the species:

Order: MYRICALES

Family: MYRICACEAE
Myrica scalariformis Kruse, sp. nov.

Order: RANALES

Family: MAGNOLIACEAE
Talauma multiperforata Kruse, sp. nov.

Order: RHOEADALES

Family: CAPPARIDACEAE
Forchhammerioxylon scleroticum Kruse, gen. et sp. nov.

Order: GERANIALES

Family: RUTACEAE
Amyridoxylon ordinatum Kruse, gen. et sp. nov.
Fagara monophylloides Kruse, sp. nov.
Fagara biseriata Kruse, sp. nov.

Family: SIMARUBACEAE
Suriana inordinata Kruse, sp. nov.

Family: EUPHORBIACEAE
Heveoxylon microporosum Kruse, gen. et sp. nov.

Order: SAPINDALES

Family: ANACARDIACEAE

Schinoxylon actinoporosum Kruse, gen. et sp. nov.
Edenoxylon parviareolatum Kruse, gen. et sp. nov.

Order: CONTORTAE

Family: APOCYNACEAE

Aspidospermoxylon uniseriatum Kruse, gen. et sp. nov.

Since the inception of this study many additional wood specimens from Eden Valley have been added to the Paleobotanical Collection of the University of Cincinnati. The majority appear to be dicotyledons, but the collection contains at least four species of monocotyledons which are probably referable to the genus *Palmoxylon* Schenk. In addition there are about a dozen specimens of fern petioles which have previously been identified as *Eorhachis lomarioides* Arnold. Gymnosperms are entirely lacking.

The assemblage of genera or affinity to genera in light of their modern distribution, seems to indicate a sub-tropical or possibly a tropical flora extant at this time and locality. This is in general consistent with the conclusions of others who have worked with compression material. If one should emphasize the occurrence of *Talauma* and genera closely akin to *Hevea*, *Schinus*, and *Aspidosperma*, one might conclude that the climate was essentially tropical, rather than sub-tropical as most students of compressions now agree. This indicates an easy source of possible error of conclusion when based on a very limited or selective flora.

At the present time, work is being done at the University of Cincinnati on the palm and palm-like fossils of this collection which should add additional paleoecological information.

ACKNOWLEDGMENTS

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LITERATURE CITED

Berry, E. W. 1916. The lower Eocene floras of southeastern North America. U.S.G.S. Prof. Paper 91: 21–491.
———. 1924. The middle Eocene and upper Eocene floras of southeastern North America. U.S.G.S. Prof. Paper 92: 1–206.
———. 1930a. Revision of the lower Eocene Wilcox flora of the southeastern United States. U.S.G.S. Prof. Paper 156: 1–196.
———. 1930b. A flora of Green River age in the Wind River Basin of Wyoming. U.S.G.S. Prof. Paper 165b: 55–81.
———. 1938. Tertiary flora from the Rio Pichileufu, Argentina. Geol. Soc. Amer. Special Papers No. 12.
Boureau, E. 1950. Étude paléoxylologique du Sahara (XI). Sur un échantillon d'Evodioxylon découvert à l'Ouest du Djebel Ben-Guénéma en Libye. Laboratoire d'Anatomie Comparée des Végétaux vivants et fossiles. Bull. du Muséum, 2nd ser., t. XXII, No. 6.
Brown, R. W. 1929. Additions to the flora of the Green River formation. U.S.G.S. Prof. Paper 154j: 279–299.
———. 1934. The recognizable species of the Green River flora. U.S.G.S. Prof. Paper 185: 45–78.

Chalk, L., and **M. M. Chattaway.** 1937. Identification of woods with included phloem. Tropical Woods 50: 1–31.
Crié, L. 1889. Beiträge zur Kenntnis der fossilen Flora einiger Inseln des Südpatifischen und Indischen Oceans. Pal. Abh., V. 2, pp. 77–90.
Dorf, E. 1942. Upper Creataceous floras of the Rocky Mountain region. I. Carneg. Inst. Wash. Pub. 508: 1–78.
Felix, J. 1882. Studien über fossile Hölzer. Inaug. Diss. 84 pp., Leipzig.
———. 1887. Untersuchungen über fossile Hölzer. III. Zeitschr. Deutsch. Geol. Gessel. XXXIX: 517–528.
———. 1894. Untersuchungen über fossile Hölzer. IV. Zeitschr. Deutsch. Geol. Gessel. XLIV: 79–110.
Hofmann, Elise. 1952. Pflanzenreste aus dem Phosphoritvorkommen von Prambachkirchen in Oberösterreich. Palaeontographica, Band XCII, Abt. B.
Hollick, A. 1924. A review of the fossil flora of the West Indies, with descriptions of new species. N. Y. Bot. Garden Bull. 12: 259–323.
Hu, H. H., and **R. W. Chaney.** 1940. A Miocene flora from Shantung Province, China. Carneg. Inst. Wash. Pub. 507: 1–147.
Knowlton, F. H. 1919. A catalogue of the Mesozoic and Cenozoic plants of North America. U.S.G.S. Bull. 696.
———. 1923. Revision of the flora of the Green River formation, with descriptions of new species. U.S.G.S. Prof. Paper 131f: 133–182.
La Motte, R. S. 1944. Supplement to catalogue of Mesozoic and Cenozoic plants of North America. 1919–1937. U.S.G.S. Bull. 924: 1–330.
Lesquereux, L. 1883. Contributions to the fossil flora. III. The Cretaceous and Tertiary floras. U.S.G.S. of the Territories.
McLaughlin, R. P. 1933. Systematic anatomy of the woods of the Magnoliales. Tropical Woods 34: 3–39.
Mercklin, C. 1855. Palaeodendrologikon Rossicum. St. Petersburg.
Metcalfe, C. R., and **L. Chalk.** 1950. Anatomy of the Dicotyledons. Oxford Univ. Press. 2 volumes.
Platen, P. 1908. Untersuchungen fossiler Hölzer aus dem Westen der Vereinigten Staaten von Nordamerika. Inaug. Diss. zur Erlangung der Doktorwürde. Leipzig.
Record, J. S. 1938. The American woods of the family Euphorbiaceae. Tropical Woods 54: 7–40.
———, and **M. M. Chattaway.** 1939. List of anatomical features used in classifying dicotyledonous woods. Tropical Woods 57: 11–16.
———, and **R. W. Hess.** 1943. Timbers of the New World. Yale Univ. Press. New Haven.
Schenk, A. 1883. Fossile Hölzer. Palaeontographica. XXX, 2, Abt. I, pp. 1–19.
Unger, F. 1850. Genera andspecies Plantarum Fossilium. Vindobonae, p. 475.

Life of The Past: An Introduction to Paleontology. *George Gaylord Simpson.* Yale University Press, New Haven. 1953. xii+198 pp. $4.00.

Those who know Simpson's *The Meaning of Evolution* will be pleased to know that he has turned his considerable literary talent to an account of the science of paleontology at a level between journalistic and professional. He has attempted to provide ". . . a nontechnical discussion of the whole scope and significance of paleontology as a science, concerned with the principles and interpretation of the history of life and not only with the identification of objects called fossils." That purpose has been fulfilled admirably. Chapters 1–5, including kinds of fossils and the evolution of man's understanding of them, their use to the geologist, their significance as living things, and paleoecology, are excellent as they stand. Chapter 6, on "Fossils and Geography" may have too much in a small package for the nonprofessional. The discussion of faunal regions would be greatly aided by a map. Simpson retains the typical North American attitude toward continental drift, and argues so persuasively against it that the uninitiated may think they have heard the final truth on that subject. Chapters 7–10, on the diversity of life, changes through time, modes of evolution, and theories of evolution, are generally good, although the discussion of modes of evloution seems a bit weighty in view of the purpose of the book. The thrust at neo-Lamarckism (p. 144) would have been clearer and more telling if he had said, "The only significant support for (it) now. . . .is in the U.S.S.R., where (if the political bosses so decree, *only* error may be expressed)." Chapter II, expressing a *raison d'être* for paleontology, is masterful in every respect. It might well be read to every class in historical geology or paleontology before beginning the study of fossils. The book is made more useful to the lay reader by the inclusion of an appendix that gives a synopsis of the kingdoms of living things.

MALCOLM P. WEISS

RECENT CHANGES IN THE INDUSTRIAL DEVELOPMENT OF NEWARK, OHIO

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The role of the small manufacturing city in our nation's industrial structure is becoming increasingly important. In 1947 only 40 percent of the persons engaged in manufacturing in the United States worked in factories in cities larger than 100,000. It is the purpose of this paper to evaluate, from the geographical viewpoint, recent changes in the industrial development of one of these smaller cities in east-central Ohio.

TABLE 1

Number of employees in Newark's industries, 1950–51

			Percent	Percent
Glass Products		3,220		50
Fiberglas products	2,600		40	
Table glassware	400		6	
Prismatic glass	220		4	
Metal Products		2,526		38
Stoves	1,123		17	
Fabricated metal	351		5	
Aluminum wire and cable	750		11	
Munitions	250		4	
Heating apparatus	52		1	
Paper		328		4
Foods		269		3
Printing and Publishing	166			2
Chemical and allied products		47		1
Other industries		96		2
Totals:		6,652		100

Source: U. S. Employment Service and contracts with individual factories.

The information and data used in the prosecution of this study have been secured by means of field investigation supplemented by a rather limited amount of background material available from library sources. Carefully prepared industrial questionnaires, accompanied by letters explaining the nature of the problem, were distributed to the appropriate representatives of the 31 major industrial concerns of Newark. These served to introduce both the problem and the investigator and were followed by personal interviews in which a more intensive examination of the individual establishments was made.

Newark is located approximately 33 miles east of Columbus in the eastern extremity of the Central Lowland province (fig. 1). Its site is the junction of the North Fork and Licking rivers. Long the nucleus of a prosperous, though somewhat limited agricultural area, Newark has experienced a definite "industrial awakening" during the post World War II period.

Approximately 3,200 people are employed in the 20 factories of southwest Newark (table 1). More than two-thirds of these are associated with metal

goods. No other section of the city is represented by such a diversity of products: stoves, fabricated structural steel, heating apparatus, aluminum wire and cable, and petroleum refining. This area has a definite linear pattern of industry, with solid industrial belts paralleling the two major railroads, which lead into the city from the south and southwest (fig. 2). Higher and more nearly level land,

Figure 1. Location map of THE NEWARK AREA.

unrestricted by valley walls, makes this an attractive area for industrial expansion and many of the post-war plants are locating here. There are several large factories in this section of Newark. Here is the city's second largest plant, the Newark Stove Company, which employs over a thousand people producing stoves, vertical heaters, and electric roasters for Sears-Roebuck and Company. Perhaps the plant which has had the most spectacular development during the World War II and post-war years is the Kaiser Aluminum and Chemical Corporation,

a "war-baby" purchased from the War Assets Administration in 1949, and producer of aluminum wire and cable. Although the process of manufacture is an almost continuous, fully automatic operation, the average number of employees in 1950 was 750 and, with the expansion of new products, the number of workers is increasing yearly.

A recent addition to Newark's industrial community, the Timken-Detroit Axle Company's Ohio Axle and Gear Division, has started production of axles and transfer cases for military trucks and, at full capacity, will employ approximately 1,600 persons. Location of the plant is in keeping with a basic program of Timken-Detroit, which closely follows recommendations of the National Security Resources Board regarding dispersal of manufacturing facilities. In response to an inquiry concerning industrial location the following interesting

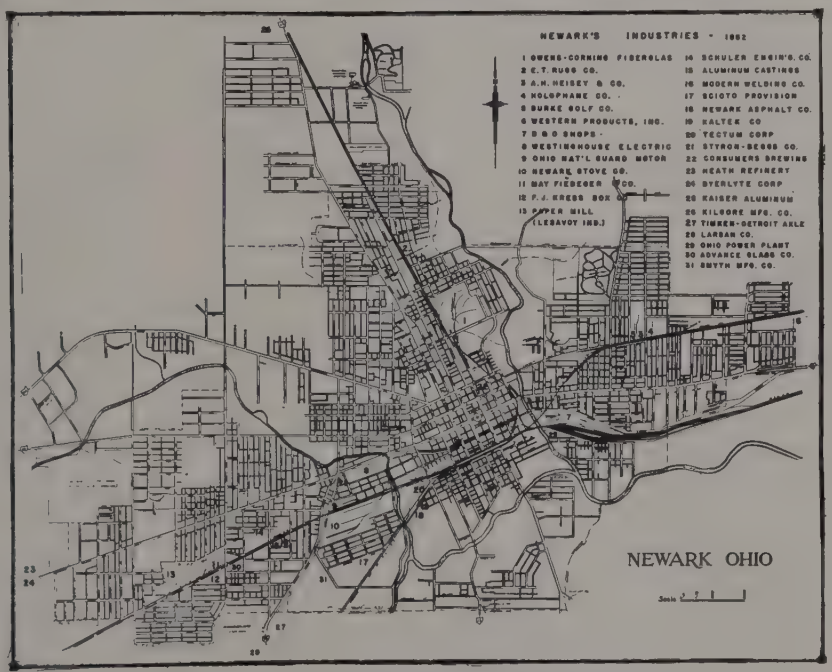

FIGURE 2. Newark's leading industries—1952.

comments were made: "This plant (Newark's) is a fine example of the growing trend toward decentralization. The motor trucks, which carry a continuous stream of materials to Newark, actually function as part of our assembly line. We are now operating nine production plants in strategically located centers: Oshkosh, Wisconsin; Detroit and Jackson, Michigan; Utica, New York; New Castle, Pennsylvania; Kenton and Ashtabula, and now Newark, Ohio."

Although containing but three of the city's 31 major industries, the northern industrial section of Newark is conspicuous in total number of persons employed. Here is the Owens-Corning Fiberglas Company, employers of approximately 2,600 workers and producers of insulation for home appliances, as well as for building construction. During the World War II period Owens-Corning received a great impetus to its growth through receipt of war contracts, mainly for the Army Air Force, which could use very effectively the light-weight insulating

materials. Owens-Corning is attempting to meet rising competition by improvement of processes and materials, reduction of costs, and creation of new products, thereby developing greater diversity.

The eastern industrial section of Newark lies in the broad valley of the Licking, just east of the North and South Fork junction (fig. 2). Only 700 people are employed by its industries, yet this is perhaps the most homogeneous collection of factories in the city, since two of the three major plants are associated with glass products. Two of the three divisions of the glass industry are represented: the A. H. Heisey and Company, manufacturers of fine table glassware, and the Holophane Glass Company, producers of illuminating and prismatic glass. Since the end of World War II, Heisey has been receiving a substantial amount of foreign competition which is due, to a great extent, to the new or rejuvenated glass industry of Japan. The Heisey Company, with an employment of from 500 to 600 people, reports an output of 300,000 barrels of table glassware annually. At one time Heisey manufactured all the glass that Holophane used but today the company does not subcontract.

The Holophane Glass Company, producers of illuminating and prismatic glass, employed 220 workers in 1950, a decided increase over the 125 figure reported for 1940. Its product is of a durable nature and its market is in the international commercial and consumer construction field. To meet the problem of a world-wide market the company has established subsidiary plants in Canada, England, and France, with a new plant being constructed in Mexico. Holophane is thus locating near the market.

Construction is to begin soon on a huge plant in Newark for the manufacture of aircraft parts for the United States Air Force. This plant will be located on a 380-acre tract along Hebron Road, a site now occupied by two large units of the Kaiser Aluminum and Chemical Corporation. This will be a government-owned installation and placed under the control of the United States Air Force. As the new installation will use a light metal, presumably aluminum, in the manufacture of aircraft parts, it is understood that the Kaiser plant will be designated to operate the facility. Included in the program are the design, construction, and operation of heavy forging and extrusion presses, larger than any heretofore built and operated in this country. Discussions have included the technical advantages and limitations of a forging press of a 75,000-ton capacity.

Until 1948 the Pharis Rubber Company, manufacturer of automobile and bicycle tires, was one of the city's principal industries. Its importance in the industrial structure is revealed in a payroll figure of 1,000 in 1940, an employment which increased to almost 2,000 persons during the war period. Concentrating on the brand-tire, mass-merchandize market, Pharis was able to prosper and meet competition largely because its production costs were lower than those of the big-name companies who dominated the markets. The local concern was able to hold its own in the replacement fields and against other independents, largely because of the wage differential which existed between the home operation and "big-rubber" in Akron. In 1948, without this differential and facing an increasing competitive market, Pharis could have little hope of producing a tire that could be sold for less and still profit sufficiently to justify remaining in business. This company was forced to liquidate its Newark plant.

The Larson Manufacturing Company, which moved to Newark in 1951, specialized in making hand saws. Two major processes are accomplished at the local plant: heat-treating of metal for the saws and cutting handles from laminated wood. Larson has made two contributions to the saw-making industry: (1) the development of a "hollow-ground" hand saw, and (2) the development of a stainless steel hand saw, which will be on the market in the immediate future. An unusually large proportion of the plant's 72 workers, about 60 percent, are women. The company has been experimenting with a greater number of women

employees doing this type of work and so far the reports have been exceptionally satisfactory.

Other industries which have located in Newark during the post-War II period include: the Westinghouse Electric Corporation, distributors of electric appliances; the Kilgore Manufacturing Company, producers of hand and rifle grenades and anti-personnel mines for the military program; Western Products, Inc., manufacturer of many types of cellophane packaging, aluminum foil, and vinyl; and Tectum, Inc., maker of a new construction material. Tectum is unique in that it was begun by local personnel and is based upon a locally developed process.

CONCLUSIONS

What then has caused this recent industrial acceleration in Newark? It may be that factors which explain industrial location here can explain the development of manufacturing in other small cities which have suddenly become industrialized.

The government-built plant of World War II has been converted to peacetime use. The Kaiser Aluminum and Chemical Corporation took over the city's single war-plant facility. This choice was made because of the available labor and accessibility, plus the fact that the national structure of the Kaiser Corporation seemed to make this a desirable location. These same two factors were likewise attractive to Timken-Detroit Axle Company in carrying out its functional decentralization policy of establishing a branch plant within the permissive range of the parent factories. These industries in turn have become attractive to other manufacturers. Accessibility and factory space have brought the Westinghouse Electric Corporation to Newark where it occupies a number of buildings vacated by the Pharis Tire and Rubber Company.

It would seem, therefore, that Newark is representative of some types of industries now exhibiting tendencies to recentralize, induced largely by the desire to secure a little cheaper and a more peaceful labor force. Newark's size and accessibility have enabled the city to participate in this recentralization of industry. Newark lies midway between the producers of special steels and the final assembly of some products. From observations the writer is inclined to believe that the nearness to Columbus' growing demand for labor may soon limit the number of industries that will be attracted to Newark.

Diversification of Newark's industries affords some insurance against a general collapse of its economic life. This proved to be the situation in 1948 when the Pharis Rubber and Tire Company was forced to liquidate its operations in Newark. Within one year its employees were absorbed into other manufactures, and within two years the principal building was occupied by the Westinghouse Electric Corporation for storage.

That available labor in Newark is being depleted is evidenced by the Newark Stove Company, which is drawing upon West Virginia counties for a part of its needs. One must conclude that Newark's factories accept this labor pool as an integral part of the economic complex. One must further conclude that the trend away from the home-owned-and-controlled manufacturing establishments to the branch plants of national concerns which are embarked upon a program of functional recentralization, is, in all probability, a permanent development.

SELECTED BIBLIOGRAPHY

1. Manufacturers Directory. 1949. State of Ohio Department of Industrial Relations, Division of Labor Statistics, Columbus.
2. Division of Research and Statistics, Ohio Bureau of Unemployment Compensation, Columbus, 1953.
3. **Wright, A. J.** 1953. Economic geography of Ohio. Division of Geological Survey, Bul. 50, 4th S.

MARITAL STATUS AS A CATEGORIC RISK IN MAJOR MENTAL DISORDERS

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Many unsupported statements have been made concerning the relation of marital status to mental illness. Some proponents claim that marriage prevents mental illness; others support the contention that, if anything, marriage precipitates incipient mental illness.

From scientific points of view, based on research in marriage and the family, both of these statements are of some validity. The main purpose of this study is to determine how the marital status of first admissions to Ohio State mental hospitals is related to the frequency and type of their mental illnesses. Thus, this study is not a study in social causation but rather a study of mental illness risk in terms of the categoric risk of marital status.

METHODOLOGY

All first admissions (2620) to Ohio State mental hospitals having major mental disorders, i. e., the most common mental illnesses, for the year ended December 31, 1949, were classified by sex, mental disorder, and by marital status. Rates of first admissions per 100,000 Ohio population 14 years and over, and of like marital status, were computed on the basis of figures obtained from the 1950 census of Ohio (Brunsman, 1952).

FINDINGS

For a summarization of the comparative rates of male and female first admissions, see the following:

An examination of table 1 indicates first, that fewer females than males are found in all marital status groups taken as a whole. Among single persons, about 4 times as many men are admitted with syphilitic psychosis, and 6 times as many men with alcoholic psychosis as are women with such psychoses.

For married persons, the greatest sex difference exists in the rates for alcoholic psychosis—more than 10 times as many men. Almost twice as many married men as married women are admitted with syphilitic psychosis. However, about two and one-half times as many married women as married men are admitted with schizophrenia.

Among widowed and divorced persons, about 4 times as many men are admitted with syphilitic psychosis, and 9 times as many men with alcoholic psychosis as are women with such psychoses.

Schizophrenia is the leading mental illness among single males with a rate of 22.9 per 100,000 Ohio single males 14 years of age and over. Psychosis with cerebro-arteriosclerosis and alcoholic psychosis are second and third with rates of 7.1 and 5.4 respectively. Male first admissions had a rate of 3.9 for syhilitic psychosis, the lowest rate for males of all marital statuses. Single males also had the lowest rates of psychosis with cerebro-artiosclerosis, senile psychosis, involutional psychosis, and manic-depressive psychosis.

The mental disorders having the highest frequencies among married males were psychosis with cerebro-arteriosclerosis, 8.5; alcoholic psychosis, 4.3; schizophrenia and syphilitic psychosis with 4.2 each. Married men, among men of all marital statuses, had the lowest rates of alcoholic psychosis, schizophrenia, paranoid conditions, and psychoneurosis. Among men who had ever been married (that is, excluding single men), men still married had the lowest rates in all major mental disorders.

With the exception of schizophrenia, widowed and divorced males had the highest rates of admission for all major mental disorders. Within this group, psychosis with cerebro-arteriosclerosis, senile psychosis, alcoholic psychosis, and syphilitic psychosis were most frequent with rates of 42.4, 34.3, 27.6, and 18.6 respectively. Comparative rates for male first admissions of all marital status groups as a whole were as follows: (*a*) widowed and divorced, 151.0; (*b*) single, 49.4; and (*c*) married, 32.7.

As among single males, the rate of schizophrenia among single females was the highest within that group and all marital status groups. The other leading mental illnesses of single females were the psychoses of old age—senile psychosis and psychosis with cerebro-arteriosclerosis. Single females, among all marital status groups, had the lowest rates of syphilitic psychosis, involutional and manic-depressive psychosis, and psychoneurosis.

TABLE 1

Comparative rates of male and female first admissions to Ohio State Mental Hospitals, by mental disorder, by marital status, year ended December 31, 1949

(Rates based on 100,000 Ohio population 14 years old and over, according to the 1950 census)

MENTAL DISORDER	MARITAL STATUS					
	SINGLE		MARRIED		WIDOWED OR DIVORCED	
	Male	Female	Male	Female	Male	Female
TOTAL	49.4	38.0	32.7	32.0	151.0	96.4
Syphilitic Psychosis	3.9	0.9	4.2	2.6	18.6	4.5
Alcoholic Psychosis	5.4	0.9	4.3	0.4	27.6	3.0
Psychosis with Cerebro-Arteriosclerosis	7.1	5.5	8.5	4.1	42.4	34.5
Senile Psychosis	2.8	2.9	3.9	1.9	34.3	22.7
Involutional Psychosis	1.6	2.6	2.0	5.1	5.2	8.0
Manic-Depressive Psychosis	2.3	2.4	2.8	3.7	3.3	6.6
Schizophrenia	22.9	19.3	4.2	10.7	14.8	13.0
Paranoid Conditions	1.2	1.4	1.1	1.1	1.9	1.6
Psychoneurosis	2.2	2.1	1.7	2.4	2.9	2.5

Schizophrenia was the leading mental illness among married women with a rate of 10.7. The second leading mental illness among married women is involutional psychosis, and third is psychosis with cerebro-arteriosclerosis. Married women had the lowest rates, among all marital status groups, of alcoholic psychosis, the psychoses of old age, schizophrenia, and paranoid conditions. Among females who had ever been married and have remained married, married women had the lowest rates in all major mental disorders.

Again, as in males, with the exception of schizophrenia, widowed and divorced females had the highest rates of first admissions for all major mental illnesses. Within this group, the psychoses of old age and schizophrenia ranked highest. Comparative rates of female admissions for all marital status groups as a whole were as follows: (*a*) widowed and divorced, 96.4; (*b*) single, 38.0; (*c*) married, 32.0.

DISCUSSION

Our data indicate that, on the basis of the reported incidence of mental illness, marital status is a categoric risk for mental disorders in general, and for specific mental disorders. Thus, married men and married women have the lowest rates of admission to mental hospitals. For single persons the rates are slightly higher than for married persons, but for widowed or divorced persons the rates are from about three to five times as high.

Within each marital status group there are differences in rates of types of

mental illnesses which are due primarily to the factors of age at admission and sex. Thus, among single first admissions, since they are the youngest group, schizophrenia as a major mental disorder (median age 32) is the highest ranking mental illness. (Pub. Welf. Stat., 1951). Schizophrenia is the psychosis of youth and early adulthood; very few persons develop it after age 50. Because of their youth, single persons, therefore, have the lowest rates of manic-depressive psychosis and involutional psychosis—two illnesses which occur most often between the ages of 35 and 60, among middle-aged people. (Frumkin, 1952).

Single, aged females have higher rates of senile psychosis and psychosis with cerebro-arteriosclerosis than do married women. But single males have lower rates for these psychosis of old age than do married males. Among single males there were, however, higher rates of alcoholic psychosis and psychoneurosis (Hunt, 1944; Kaplan, 1945).

Among married persons, with the exception of those with paranoid conditions, sex differences in types of mental illnesses were fairly pronounced. Males had higher rates of syphilitic and alcoholic psychoses, and the psychoses of old age than women. Females, on the other hand, had higher rates of involutional and manic-depressive psychoses, schizophrenia, and psychoneurosis.

Sex differences among the widowed and divorced were similar to those among the married, except that men had higher rates of schizophrenia and psychoneurosis. According to the Metropolitan Life Insurance Company, 60 percent of persons of age 65 and over are widowed. (Stat. Bull., 1952) Since the median ages of first admissions to Ohio State mental hospitals with psychosis with cerebro-arteriosclerosis and senile psychosis were 69 and 76 respectively, (Publ. Welf. Stat., 1951), it is understandable why the rates for widowed and divorced are so much higher than those of married persons.[1] Eliminating the aged, psychotic widowed persons, we find the remaining divorcees with exceedingly high rates of syphilitic and alcoholic psychoses and schizophrenia.

SUMMARY

This study of mental illness risk in terms of the categoric risk marital status does not amount to the study of the causes of mental illness. The findings in this study indicate, however, that marital status is a categoric risk factor in mental illness. Married persons therefore have the least chances of acquiring major mental disorders, and divorced or widowed persons have the greatest chances. Single persons have less of a chance of becoming mentally ill than divorced or widowed persons but a greater chance than married persons.

Since this study is largely concerned with the group phenomena, and is actuarial rather than individual in character, a clinical study of the individual in relation to his marital status and mental health is needed. This is a task, however, for the clinician and is beyond our scope of inquiry. On the basis of the findings in this study, further research on the problem of marital status and mental illness seems warranted.

REFERENCES

1. **Brunsman, H. G.** (Editor). General Characteristics of Ohio. 1952. 1950 Population Census Report P-B35. Washington, D. C., U. S. Government Printing Office.
2. **Frumkin, R. M.** 1952. The most common psychogenic mental illnesses of prolonged-care and receiving hospital patients—a comparative analysis. Pub. Welf. Stat. 7: 8–11. (Nov.)
3. **Hunt, J. McV.** (Editor). 1944. Personality and behavior disorders. Ronald Press Co., New York.
4. **Kaplan, O. J.** (Editor). 1945. Mental disorders in later life. Stanford University Press, Stanford.
5. Pub. Welf. Stat. 1951. 6: 52. (May).
6. Stat. Bull. 1952. 33: 1–3. (October).

[1]More than 73 percent of the widowed persons had psychoses of old age, whereas only about 15 percent of the divorced persons had these psychoses.

A SURVEY OF THE HELMINTH PARASITES OF FISHES FROM VAN BUREN LAKE AND ROCKY FORD CREEK

RUSSELL F. KRUEGER[1]

Department of Biology, Bowling Green State University, Bowling Green, Ohio

This survey of the helminth parasites of fishes from Van Buren Lake and Rocky Ford Creek was initiated in July, 1950 and completed in November, 1950. It was an attempt to supplement and substantiate known data on helminth parasitism of fishes through a study of helminths from fishes of a very specific and limited body of water.

In any study of Van Buren Lake, consideration and attention must be given to Rocky Ford Creek which is the chief source of water at one end of the lake and serves at the opposite end as a carry-off for excess water. Therefore, five hundred yards of Rocky Ford Creek above and below the lake was included for collections of fishes for this survey.

TABLE 1

A summary of parasitism of the fishes collected from Van Buren Lake and Rocky Ford Creek.

Family	Genus and Species	Common Name	Number Examined	Number Parasitized
Ameiuridae	*Ameiurus melas* (Rafinesque)	Black bullhead	15	14
	Ameiurus nebulosus (Le Sueur)	Brown bullhead	8	8
Catostomidae	*Catostomus commersonnii* (Lacepede)	White sucker	11	7
Centrarchidae	*Lepomis cyanellus* Rafinesque	Green sunfish	15	15
	Lepomis macrochirus Rafinesque	Bluegill	12	7
	Micropterus salmoides (Lacepede)	Largemouth black bass	6	2
	Pomoxis annularis Rafinesque	White crappie	18	18
	Pomoxis nigro-maculatus (Le Sueur)	Black crappie	7	7
Clupeidae	*Dorosoma cepedianum* (Le Sueur)	Gizzard shad	7	7
Cyprinidae	*Cyprinus carpio* Linnaeus	Carp	8	6
	Hyborhynchus notatus (Rafinesque)	Bluntnose minnow	1	0
	Notemigonus crysoleucas (Rafinesque)	Golden shiner	32	29
		Total	140	120

Van Buren Lake was formed in 1939 under the direction and supervision of the Ohio Division of Wildlife. The lake and the creek sectors covered in this survey were located in section eighteen, Allen Township, Hancock County, Ohio.

One hundred and forty fishes representing five families and twelve species were collected and examined for helminth parasites. Nematodes, cestodes and trematodes were present in the fishes examined. The gills contained especially large numbers of monogenetic trematodes.

There were no known studies on the helminth parasites of fishes of Van Buren Lake. Pearce's (1950) work included a small number of fishes from Rocky Ford Creek; however, the collection stations for fishes were in Wood County and not adjacent to the lake in Hancock County.

MATERIALS AND METHODS

The fishes examined in this survey were collected with two-man seines, fyke nets, gill, trammel, and hoop nets. An attempt was made to collect nearly an equal

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number of fishes of which most were of the small and medium size. The fishes were killed immediately before examination, since it was found that the small monogenetic trematodes rapidly disintegrated after the death of the fish. The examinations were made with a binocular stereoscopic microscope. When possible, helminths were removed from the host and identified while in the living state. It

TABLE 2

A list of helminths collected from fishes of Van Buren Lake and Rocky Fork Creek, the host(s), and location(s) in the host(s).

PARASITE	HOST(S)	LOCATION IN HOST(S)
Actinocleidus longus	Green sunfish	Gills
Agamonema sp.*	Black bullhead	Mesenteries
	Golden shiner	Intestine
Allocredium ictaluri	Black bullhead	Intestine
	Brown bullhead	Intestine
	White sucker	Intestine
Camallanus oxycephalus	White crappie	Intestine and caeca
	Black crappie	Intestine
Cleidodiscus capax	White crappie	Gills
	Black crappie	Gills
Cleidodiscus diversus	Green sunfish	Gills
Cleidodiscus longus	White crappie	Gills
	Black crappie	Gills
Cleidodiscus pricei	Black bullhead	Gills
	Brown bullhead	Gills
Cleidodiscus robustus	Green sunfish	Gills
Cleidodiscus uniformis	White crappie	Gills
Cleidodiscus vancleavei	White crappie	Gills
	Black crappie	Gills
Clinostomum marginatum	Brown bullhead	Kidney
	White sucker	Kidney
Corallobothrium fimbriatum	Black bullhead	Stomach and intestine
Crepidostomum cornutum	Green sunfish	Intestine and caeca
	Bluegill	Caeca
	Black crappie	Intestine
Dactylogyrus extensus	Carp	Gills
Dichelyne cotylophora	Black bullhead	Mesenteries
	White sucker	Liver
	Green sunfish	Stomach and intestine
	White crappie	Intestine
Glaridacris catostomi	White sucker	Stomach
Gyrodactylus spathulatus	White sucker	Gills
Haplocleidus furcatus	Green sunfish	Gills
	Bluegill	Gills
Hymenolepis sp.*	Green sunfish	Intestine and caeca
	Bluegill	Caeca
	Golden shiner	Stomach and intestine
Mazocraes cepedianum	Gizzard shad	Gills
Monobothrium ingens	White sucker	Intestine
Neascus sp.*	White sucker	Liver (encysted)
	Green sunfish	Integument and mesenteries (encysted)
Posthodiplostomum minimum	Black bullhead	Intestine
	Green sunfish	Intestine and spleen
	Bluegill	Caeca, kidney, liver, and mesenteries
	Black crappie	Stomach, intestine, liver and mesenteries
Onchocleidus cyanellus	Green sunfish	Gills
Onchocleidus mucronatus	Green sunfish	Gills
	Bluegill	Gills
Onchocleidus perdix	Bluegill	Gills
Onchocleidus principalis	Largemouth black bass	Gills
Proteocephalus ambloplitis	Brown bullhead	Intestine
Pterocleidus biramosus	Black crappie	Gills
Spinitectus carolini	Green sunfish	Intestine
	Bluegill	Intestine
	Largemouth black bass	Intestine
Spinitectus gracilis	Green sunfish	Intestine
Triganodistomum attenuatum	White sucker	Stomach and intestine
Triganodistomum simeri	White sucker	Intestine

* Indicates only larval forms collected.

was almost imperative that monogenes be identified immediately because they were exceedingly difficult to handle for preparation of permanent slides and were present in such large numbers and in mixed infections. The unidentified or doubtful helminths were prepared for identification from stained specimens.

The cestodes and trematodes which were stained to facilitate identification were killed and fixed with Bouin's fixative. The nematodes were killed in warm seventy

percent alcohol solution, and transferred to Bouin's fixative when dead. In carrying a monogenetic trematode or a small digenetic trematode through the various steps preparatory to permanent mounting, the specimens were more easily handled by affixing them to a small tab of paper which was coated with Mayer's albumin. The coated tab of paper was pressed lightly to the trematode which had previously been killed and fixed in Bouin's. Coagulation of the albumin in warm Bouin's firmly attached the minute specimen so that in dehydration or staining they were more easily controlled. All specimens were stained with alum cochineal, cleared with either xylol or clove oil, and then mounted in Harleco Synthetic Resin.

DISCUSSION

From one hundred and twenty fishes, thirty-three different species of helminths were identified while in twenty fishes none were found. The parasites were obtained from the digestive tract, gills, integument, kidneys, liver and mesenteries. The degrees of infection of helminths varied but were generally consistent with the species. In all, seventeen species of monogenetic trematodes, seven digenetic trematodes of which three are larval forms, five species of cestodes with one larval form, and four species of nematodes were identified. Agamonema sp. is listed to include immature nematodes of unknown species.

The most significant information gained concerning parasitism by this survey was the presence of seventeen species of monogenetic trematodes. Eighty-two fishes had gill infections. Fishes like the green sunfish and the black and white crappies contained large numbers as well as several species of parasites.

The digenetic trematodes, cestodes and nematodes were of subordinate importance because of the numbers and species present. Acanthocephala were not found in this survey.

An immature *Hymenolepis* sp. recovered from the green sunfish, bluegill, and golden shiner was impossible to identify by means of hook shape, size, or number. Per anum and per os inoculations of chicks and muscovy ducklings failed to serve as an aid in identification.

Any attempted conclusion drawn from this survey is subjected to such limitation factors as: the number of fishes examined; species, size, and age of fishes; variation aquatic environment; and climatic conditions. In spite of such limiting factors, the survey does present a pressing helminth-fish relationship existing in the fishes from this small definite limited waters.

REFERENCES

Pearce, W. J. 1950. A survey of the helminth parasites of fishes from Lake Erie and Ohio River drainage areas. M.A. thesis. Bowling Green State University, Bowling Green, Ohio.

An Introduction to Laboratory Technique in Bacteriology. *Max Levine.* The Macmillan Company, New York. Third Edition, Revised, 1954. xviii+413 pp. $4.50.

This revised, third edition contains 122 exercises, designed for courses in general bacteriology. The exercises are arranged into eight sections which include: methods of sterilization, morphology and staining characteristics of microorganisms, nature, use and preparation of nutrient media, cultural characteristics of microorganisms, chemical activities of microorganisms, the effect of physical and chemical agents on bacteria, the quantitative estimation of bacteria, and agglutination reactions. There is a comprehensive section on the techniques used in sanitary and food bacteriology. Five appendices include: dichotomous keys for common species of bacteria, the preparation of standard and special culture media, the preparation of stains and special staining procedures, the preparation of reagents and tests for metabolic products, and a glossary of descriptive terms.

In each exercise, the procedure is preceded by a statement describing the purpose of the experiment and a list of required materials. The procedures are clear and concise and arranged in an orderly sequence. References are included with most of the exercises.

J. N. Baldwin

A NEW OHIO LOCALITY RECORD FOR THE GILLED OLIGOCHAETE *BRANCHIURA SOWERBYI*

ROBERT L. STRECKER

Department of Zoology, Miami University, Oxford, Ohio

The aquatic oligochaete, *Branchiura sowerbyi*, was first described by Beddard (1892) from a tank in the Royal Botanical Society's Garden in London, and has since been recorded in the eastern hemisphere from various localities in Europe, Japan, China, Java, and Australia (Spencer, 1932). In 1930 and 1931 it was collected from the bottom mud of Buckeye Lake, Ohio and described in some detail by Spencer (1932). It is characterized by having a slender finger-like gill on the dorsal and ventral surface of each segment for approximately the posterior third of the worm, and is readily identifiable because of this peculiarity.

On the campus of Miami University there are several small mud bottom ponds called the Fisher Ponds, and in May, 1952, several specimens of this worm were collected by Alan Sogg, a student at the University. Collections were made again in May, 1953, and the worms appeared to be fairly common in two of the ponds.

According to Pennak (1953, and correspondence) these worms have also been found in Michigan, Iowa, Illinois, Wisconsin, and Tennessee. Evidently this species is more abundant and more widely distributed throughout the midwestern United States than published records would indicate.

REFERENCES

Beddard, F. E. 1892. A new branchiate Oligochaete (*Branchiura sowerbyi*). Quart. Jour. Micr. Sci. 33: 325.

Pennak, R. W. 1953. Fresh-water invertebrates of the United States. Ronald Press, New York. 769 p.

Spencer, W. P. 1932. A gilled oligochaete *Branchuria sowerbyi* new to America. Trans. Amer. Microsc. Soc. 51: 267–272.

Fundamentals of Ecology. *Eugene P. Odum.* W. B. Saunders Company, Philadelphia. 1953. xii+384 pp. $6.50.

This attractive and substantially bound book is appropriately entitled *Fundamentals of Ecology*. It is divided into three parts in which the principles, habitat, and applied approaches to ecology are considered. In the first part the author has approached the subject by outlining the broad principles of ecology and has followed these with examples which aid in their understanding and application. He has drawn on both plant and animal interrelationships for his examples and has in some cases added warnings to prevent a faulty or immature conclusion in the application of a principle. It appears to the reviewer that the presence of these examples in the book make it possible to effectively teach or learn general ecology without an extensive library so often associated with this study.

In the second part the habitat approach is effectively presented. In this part fresh water ecology, marine ecology and terrestrial ecology are treated in terms of environments usually considered only in specialized fields. These sections are also illustrated with pertinent examples drawn from ecological publications.

The third part deals with applied ecology in which the application of ecology to natural resources, public health and welfare and human society are discussed.

Several hundred well chosen references are listed in the bibliography which contains titles and page numbers as well as the publication. It also contains 120 illustrations in the form of charts, graphs and photographs. This book is rich in aids for the teacher or student of ecology in the field or in the classroom.

MAURICE L. GILTZ.

ANNUAL REPORT OF THE OHIO ACADEMY OF SCIENCE
1954

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THE OHIO JOURNAL OF SCIENCE 54(4): 281, July, 1954.

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REPORT OF THE SIXTY-THIRD ANNUAL MEETING OF THE OHIO ACADEMY OF SCIENCE

The sixty-third annual meeting was held on the Ohio University campus on April 15, 16 and 17. This was part of the Sesquicentennial Program of the University. This meeting occurred during a vacation period so that all facilities of the University were available to the members of the Academy and all needs had been anticipated and well planned for.

The sixth annual State Science Day of the Ohio Junior Academy of Science was held on April 16 with the largest number of projects and largest attendance in the history of the organization. 286 projects were entered with 246 exhibits being presented by approximately 275 Junior Academy members.

Well organized and well attended programs were presented by the sections in Zoology, Plant Sciences, Subsection in Genetics, Geology, Medical Sciences, Physics and Astronomy, Geography, Chemistry, Science Education, Anthropology and Sociology, and Conservation. The Ohio Section of the American Physical Society met in joint session with the section in Physics and Astronomy. Commercial exhibits were presented by six companies. The University sponsored a tea for all ladies in attendance at which the wives of the Science faculty members of Ohio University served as hostesses.

The annual banquet and business meeting were held in the Ballroom of the Ohio University Center on Friday evening at 6:00 P.M. Dr. F. H. Krecker, a past president of the Academy and retiring secretary of the Junior Academy of Science, served as toastmaster. Greetings from Ohio University were extended by Dr. W. S. Gamertsfelder and the response of the Academy by Dr. W. H. Shideler. The presidential address given by Dr. R. A. Hefner was titled, "Selective Factors in Human Survival".

The following persons were announced as newly elected fellows of the Academy:

R. S. Baby	J. F. Hall	S. M. Mayfield
J. F. Buckingham	Mrs. Clara Kenney	G. W. Sinclair
J. R. Coash	A. G. Linschied	W. E. Singer
A. N. Dingle	Meno Lovenstein	E. E. Terrell
Frank Dudley	Duncan McConnell	Mrs. Bertha Whitmore

Dr. F. H. Krecker announced that awards to outstanding high school teachers were presented to Mrs. Clara Kenney, Hunington Rural; Miss Phyllis Read, Mogadore; Mrs. Bertha Whitmore, Columbus West; Floyd Combs, Cambridge Junior High; Gerald Ernst, Zone School; and H. R. Hornbrook, Eaton. The Kroger award for outstanding work in sciences in the high schools was presented to Mogadore High School.

The membership approved the acceptance of the revised constitution. The report of the Nominating Committee was presented by Dr. R. P. Goldthwait and for the Resolutions Committee by Dr. E. S. Thomas.

Respectfully submitted,

Rush Elliott, *Secretary*

REPORT OF THE EXECUTIVE COMMITTEE AND COUNCIL

The Executive Committee met on December 4, 1953, and again on April 15, 1954, and the Council on December 5, 1953, and again on April 15, 1954.

The report of a special committee to revise the constitution was received and approved subject to final approval of the members of the Academy at the Annual Business Meeting.

A plan was approved for rotation of replacements of the University and/or College District Representatives on the Council of the Junior Academy of Science. The resignation of Dr.

F. H. Krecker as Executive Secretary of the Junior Academy of Science was accepted and Professor R. E. McKay was appointed to the position effective immediately following the Annual Meeting.

The Section in Psychology (E), and Section in Mathematics (I) were dissolved according to the provisions of the Constitution and the remaining sections are to be labeled alphabetically and consecutively from A through J.

The 1955 Annual Meeting is to be held at Ohio Wesleyan University on April 21, 22 and 23, and the 1956 meeting at Bowling Green State University.

Respectfully submitted,

RUSH ELLIOTT, *Secretary.*

REPORT OF THE TREASURER

CURRENT EXPENSE FUND

Fiscal Year 1953

RECEIPTS:	
Bank Balance, January 1, 1953	$1,821.92
Membership dues	4,444.00
Sale of Publications	30.23
Interest U.S. Bonds	47.50
Grant. Chas. F. Kettering Foundation	500.00
Ohio Psychological Association	25.00
Miscellaneous	.50
	$6,869.15
EXPENDITURES:	
Subscriptions and Engraving Ohio Journal of Science	$2,307.34
Printing Annual Report	136.28
Printing News Letter. Junior Academy	124.00
Programs for Annual Meeting	172.00
Postage, office supplies, bank charges and other administrative expense	732.49
Academy Conference	5.00
Signs for Annual Meeting. (Ohio State)	12.00
Bank Balance December 31, 1953	3,380.04
	$ 6,869.15

OHIO ACADEMY OF SCIENCE RESEARCH FUND

Fiscal Year 1953

RECEIPTS:	
Bank Balance, January 1, 1953	$ 230.21
Interest U.S. Bonds	7.50
Interest Fort Hayes Hotel Bonds	26.00
Dividends, Banc-Ohio Stock	31.25
Grant A. A. A. S.	195.00
	$ 489.96
EXPENDITURES:	
Grant. Cecil Riser	50.00
Grant. Elizabeth W. Smith	100.00
Grant. Janice C. Beatley	140.00
Bank Charges	2.63
Bank Balance. December 31, 1953	197.33
	$ 489.96
Excess Expense over Income	$ 32.88

Fort Hayes Hotel Bonds have been called.

Respectfully submitted,

R. M. GEIST, *Treasurer.*

REPORT OF THE TRUSTEES OF THE RESEARCH FUND

Fiscal Year 1953

RECEIPTS:	
Bank Balance	$ 230.21
Interest U.S. Bonds	7.50
Interest Fort Hayes Hotel Bonds	26.00
Dividends Banc-Ohio Stock	31.25
Grant A. A. A. S.	195.00
Total Receipts	$ 489.96

EXPENDITURES:	
Grant, Cecil Riser	$ 50.00
Grant, Elizabeth W. Smith	100.00
Grant, Janice C. Beatley	140.00
Bank Charges	2.63
Bank Balance December 31, 1953	197.33
Total Expenditures	$ 489.96
Examination will show excess expense over income	$ 32.88

Fort Hayes Hotel Bonds were called.

1954

Cash in Bank January 1, 1954	197.33
Fort Hayes Hotel Bonds cashed	1,300.00
Deposit January 9, 1954	13.75
Deposit April 6, 1954	7.50
Cash in Bank April 15, 1954	$1,518.58

Respectfully submitted,

E. S. THOMAS,
G. W. Blaydes,
K. G. A. BUSCH, *Chairman*

REPORT OF THE LIBRARIAN

The librarian is pleased to inform the Academy that its official journal is used in four hundred and ninety-eight exchanges. Seventy-one percent of these exchanges are with public and private institutions located abroad. Twenty-nine percent of these exchanges are with domestic institutions.

There has been a 10.5% increase in the number of exchanges since the librarian's previous report.

EXCHANGE AGREEMENTS CONCLUDED BETWEEN THE O.A.S. AND DOMESTIC AND FOREIGN INSTITUTIONS

	April 1953	April 1954	Numerical Gain	Percent increase over 1953
Domestic exchanges	134	144	10	10.7
Foreign exchanges	337	354	17	10.5
Total number of exchanges	471	498	27	10.5

Sales of the Academy's publications for the period, July, 1953 through December, 1953, amounted to ten dollars and forty-nine cents ($10.49). Seventy-five cents was withheld for the purchase of tax stamps; the remainder of the money, nine dollars and seventy-four cents ($9.74), was turned over to the Treasurer of the Academy.

Respectfully submitted,

MORTON COBURN, *Librarian*

REPORT OF THE JOINT ADMINISTRATIVE BOARD OF THE OHIO JOURNAL OF SCIENCE

The annual meeting of the Joint Administrative Board of the Ohio Journal of Science was held at Columbus on April 3, 1954. The meeting was called to order by Board Chairman Spieker. Present were Drs. Spieker and Meyer representing the Ohio State University, Drs. Lindsey and Beaver representing the Ohio Academy of Science, and Drs. Böhning, Popham, and Fisk of the Ohio Journal of Science staff.

Dr. Spieker was elected chairman of the board for the year 1954–55.

Minutes of the last meeting were approved as read.

The report of the business manager was approved as read. This report, which accompanies these minutes, is mainly in the form of a financial statement for Volume 53. Dr. Popham announced the favorable action of the Executive Committee of the Academy to transfer the $500 gift by the Kettering Foundation to the Journal. The money is being used to enlarge certain numbers of the Journal in order to reduce the very large backlog of papers awaiting publication. He also announced that Journal funds would be used to continue the publication of enlarged issues of the Journal until the backlog of papers is reduced to reasonable size. Dr. Popham called attention to the fact that the $250 allowance of the Academy for the purpose of paying one-half of the cost of plates for the Journal has proved inadequate to meet this expense during the past three years. After some discussion of this matter the board instructed the business manager to request the Council of the Academy to annually allot a sum of money sufficient to pay for one-half the cost of plates appearing in the last completed volume of the Journal.

The report of the editor was approved as read. The editor indicated that the Journal was, in April,1953, 12 months behind in the publication of papers. It is now only about 10 months behind. He expects this period of delay to be reduced to the minimum practicable working period within the next year. The editor initiated a discussion concerning the desirability of establishing a policy limiting the length of papers to be published in the Journal. It was decided by the board that each paper should be considered on its merits and with respect to the size of the backlog of papers awaiting publication but that the editor should have power to act as he sees fit in limiting the length of papers submitted.

Dr. Fisk presented the report of the book review editor which was approved as read. He indicated that the very large backlog of book reviews which existed a year ago no longer exists and that book reviews are now being published about as fast as practicable. One reason for the improved condition with respect to the publication of the book reviews is that a policy has been instituted limiting the length of book reviews to 150 words except in cases of books of unusual merit.

Dr. Spieker was instructed to appoint a committee to audit the books of the business manager for Volume 53.

The editor reported that the award committee of the geology section has decided not to grant The Ohio Journal of Science Award for Excellence in Research this year. The board decided not to offer The Ohio Journal of Science Award for Excellence in Research in the year 1955.

The board elected Dr. Böhning editor, Dr. Popham business manager, and Dr. Fisk book review editor for the year 1954–55.

Respectfully submitted,

RICHARD A. POPHAM
Secretary of the Board

THE OHIO JOURNAL OF SCIENCE

Volume 53—Fiscal Year 1953

BALANCE SHEET

(With comparison with previous Two Years)

	Volume 51 Fiscal Year Jan. 18, 1951 Dec. 25, 1951	Volume 52 Fiscal Year Jan. 1, 1952 Dec. 31, 1952	Volume 53 Fiscal Year Jan. 1, 1953 Dec. 31, 1953
RECEIPTS:			
Bank balance at beginning of period	$1,107.19	$1,370.64	$1,566.51
O.S.U. paid for subscriptions	1,800.00	2,000.00	2,500.00
O.A.S. paid for subscriptions	1,807.50	2,135.00	2,069.50
Non-members—paid for subscriptions	404.50	386.00	432.50
Separate numbers, volumes and reprints sold	514.48	222.30	657.15
50 year index sold	0.00	0.00	555.00
O.A.S.—paid ½ cost of plates	421.63	231.14	237.84
O.A.S.—paid for Annual Report	101.88	103.32	136.28
Miscellaneous	0.00	17.50	34.94
Advertisements	1,116.97	737.52	387.00
	$7,274.15	$7,203.42	$8,576.72
EXPENDITURES:			
Spahr and Glenn—printing O.J.S.	$4,326.61	$4,544.00	$4,843.80
Bucher Engraving—Plates	832.41	585.20	624.86
Postage and Express	211.99	214.57	281.50
Secretary and labor	118.86	48.50	125.06
Office supplies and bank charges	108.67	94.64	61.86
Advertising the O.J.S.	75.00	150.00	213.89
Spahr and Glenn—reprints	46.06	0.00	236.89
Mailing envelopes	180.91	0.00	225.77
Refunds	3.00	0.00	0.00
Miscellaneous	0.00	0.00	34.44
Bank balance at end of period	1,370.64	1,566.51	1,928.65
	$7,274.15	$7,203.42	$8,576.72
Cost of supplying one volume of six numbers	$3.204	$2.891	$3.085
Subscription price to Academy Members	$1.50	$1.50	$1.50
Approximate number of Academy Members	1150	1250	1250

THE OHIO JOURNAL OF SCIENCE

Report of the Editor of Volume 53, 1953,

to the Joint Administrative Board

Volume 53 of The Ohio Journal of Science contained 384 pages of text and 4 pages of index, not including 24 pages of cover. The text pages were devoted to 57 articles in eight fields of science (as represented by sections of the Ohio Academy of Science), to 53 book notices, and to various announcements and advertisements. Among the articles was one symposium on "The Trapping of Solar Energy".

Respectfully submitted,

R. H. Böhning, *Editor*

REPORT OF COMMITTEE ON RESOLUTIONS

Be it Resolved that the membership of the Ohio Academy of Science in session at Athens, Ohio, place on record its sense of sincere gratitude and appreciation for the generous welcome extended by its hosts on the campus of Ohio University, for the foresight and attention to detail which led to the meeting being one of the most rewarding and satisfying within memory. In the notable success of the meeting, the scientists here assembled believe they can trace the imaginative brain and resourceful hand of its own distinguished secretary. If this hypothesis be only partially correct the credit must be prorated among the team of his collaborators whose loyal help he enlisted with such particular effectiveness. It is further resolved that the secretary be instructed to convey to himself and to his colleagues the words of thanks which he is hereby requested to spread on the minutes of the transactions of the Academy.

Be it further Resolved, that the members of this Academy express their appreciation and best wishes to Dr. F. H. Krecker, who has been Executive Secretary of the Junior Academy since its founding and who is now retiring, for his keen foresight and dynamic leadership in that important work.

Respectfully submitted,

W. A. Manuel
J. B. Gebhart
G. B. Barbour, *Chairman*

NECROLOGY REPORT FOR 1953–1954

The period from April 1953 to April 1954 constitutes the time between the Annual meetings of the Academy and for this interval the deaths in the membership are recorded.

Philip W. Berg

Philip W. Berg, Assistant Professor of Zoology, Purdue University and former member of the Ohio Academy of Science in the Zoology Section, died of accidental causes at Lafayette, Indiana in January 1954.

John Ferguson Cunningham

Dean John Ferguson Cunningham, Dean of the College of Agriculture at Ohio State University from 1932 to 1947. Member (1898) and Fellow (1944) of the Zoology Section.

Dean Cunningham was born at Aften, Iowa on February 4, 1877 but spent most of his life in Ohio. He secured the Bachelor of Science degree at Ohio State University in 1897 and the Master of Science degree in 1899. He was the owner and editor of the Wisconsin Agriculturist, owner of the Florida Grower, and Editor of the Ohio Farmer. He was even in his student days active in agricultural journalism and edited the Agricultural Student Magazine which was the first of its kind and is still regularly issued. While Dean Cunningham was still publishing the agricultural journals he was elected in 1914 to the Board of Trustees of Ohio State University and served 8 years. He was a war Food Commissioner in World War I and was on the Board of Control of the Ohio Experiment Station for several years. From 1937 to 1947 he was a director of the Ohio State Research Foundation and Chairman of the Ohio Farm Chemurgic Commission and also of the Ohio Soil Conservation Committee. He was until his retirement in 1947 chairman of the Land Resources Council of the Mississippi Valley Association, comprising 23 states.

Dean Cunningham was a member of the Agricultural Editors Association, The American Forestry Association and co-founder of Alpha Zeta Agriculture Fraternity. He was also a member of Phi Gamma Delta, Sigma Xi, Gamma Sigma Delta and the Rotary Club and Fellow of the American Association for the Advancement of Science.

On October 30, 1907 Dean Cunningham married Edna Mumfer and to this union were born sons, John F. and Richard M. Cunningham. After retirement Dean Cunningham devoted much of his time to his extensive farm in Clark County. He died on April 28, 1953 of cardiac decompensation and was buried in Oakdale Cemetery, Urbana, Ohio.

Edgar H. Sarles

Mr. Edgar H. Sarles, of Norwood, Ohio was a geologist and chemist by profession and a member of the Geology Section of the Academy.

Mr. Sarles was born on August 1st 1878 in Brooklyn, New York and received the Bachelor of Science degree from Rutgers University in 1899 where he was also a member of Delta Upsilon fraternity.

For 26 years Mr. Sarles was Superintendent of the Jarecki Chemical Company and for 8 years of the Shephard Chemical Co. He was a member of the Dry Dredgers Geology Association of Cincinnati University and also President of the Mineral Society of Cincinnati.

On November 26, 1902 Mr. Sarles married Miss Minnie Hinman of Ontario, Canada. They had three children, viz. Wesley Sarles, Mrs. Ruth Sarles Benedict and Mrs. Nellie Sarles Schatz. On January 13, 1954 Mr. Sarles died of myasthenia gravis and was interred in Rest Haven Cemetery, Sharonville, Ohio.

Stephen R. Williams

Dr. Stephen R. Williams emeritus Professor of Zoology at Miami University, Member and Fellow of the Zoology Section.

Dr. Williams was born on August 22, 1870 in Kalgan, North China, the only son of his parents, Rev. and Mrs. Mack Williams, the first missionaries to that part of China. When 9 years of age he returned to the United States and lived with an Uncle and Aunt, Mr. and Mrs. Francis at Paddy's Run, near Shandon, Butler County, Ohio. He was graduated from Oberlin College with the Bachelor's degree in 1892 and received the Master's degree in 1893. He taught two years in the Lima High School and then went to Harvard University in 1900 and received his doctor's degree in Zoology. He then came to Miami University to teach botany, zoology and geology until his retirement in 1940.

During the summer Dr. Williams taught at Cold Spring Harbor Biological Laboratory from 1913 to 1933 and also at the summer laboratories of Ohio State University at Cedar Point, Ohio and Put-in-Bay. On leave of absence he studied at Munich, Germany and in Italy and in 1911 spent a year at Scripps Institute at La Jolla, California and also at the Biological Laboratory of Bermuda. He was President of the Academy in 1940.

On September 14, 1904 Dr. Williams married Miss Mary Covington of Cincinnati; she and three of their four children survive him, viz. Dr. John C. Williams, Dr. Isabella Williams, and Mrs. Harley P. Brown. A third daughter, Mary Williams, died in 1940. Four sisters, several of them missionaries, also survive him as well as 4 grandchildren.

Dr. Williams published many articles on Zoology and after his retirement a history of the Welsh settlement his ancestors founded near Shandon, Ohio entitled "The Saga of Paddy's Run." He died of cardiovascular renal complications in February 24, 1954 in the hospital at Hamilton. Services were held at Memorial Presbyterian Church in Oxford, Ohio where he sang in its choir for 27 years. After cremation his remains were interred in the cemetery at Shandon, Ohio.

James Renwich Withrow

Dr. James Renwich Withrow. Professor and Chairman of the Department of Chemical Engineering at Ohio State University. Member and Fellow of the Chemistry Section of the Academy.

Dr. Withrow was born in Philadelphia, Pa. on August 29, 1878 and educated at the University of Pennsylvania where he received the Bachelor of Science degree in 1899 and the Ph.D. degree in 1905. He was employed as research chemist for the Barratt Manufacturing Co. of Philadelphia and later came to Columbus as Professor of Chemistry in Ohio State University, finally assuming the chair of Chemical Engineering. On September 10, 1906 he married Miss Alice Steelman to whom were born three children, Mrs. Alice Withrow Field, James R. Withrow, Jr. and David D. Withrow. Dr. Withrow died on March 20, 1953 of an embolism and was buried at Tuckahoe, New Jersey.

Respectfully submitted,

H. H. M. Bowman, *Chairman*
J. H. Melvin
Paul Rothemund

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